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Alpine took victory in the 100th race of the FIA World Endurance Championship, held at Fuji, Japan, in September. It became the fourth manufacturer to win in the series this season

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Past, present and future

How the Goodwood Revival has evolved, and questions for years to come

For somebody who works in motorsport, sometimes it's good to be reminded of why you got into it in the first place. Attending races for fun, or 'fever' as the late Henry Hope-Frost exquisitely put it, helps to reconnect with the emotion that easily gets lost in the noise of what is, despite its interesting nature, a job.

For me, that sense of calibration comes at the Goodwood Revival, an event I first attended as a child in 2000. Back then, it was the most exciting thing in the world. My parents would design my outfit each year, rotating between commentator, driver and mechanic. I would spend all three days imagining we had time travelled to the 1950s, made possible by the organisers' attention to detail. Immersive actors would mingle in the crowd and vintage working vehicles would trundle about. Everyone there bought into the spirit; you stuck out like a sore thumb if you didn't. It was helped by the fact that some of the drivers – the likes of Stirling Moss, Tony Brooks and Richard Attwood – raced at Goodwood during the circuit's original 1948-1966 operational period which the Revival celebrates. A human connection to times past.

Now approaching my fourth decade, I try not to let nostalgia cloud my experience. Goodwood is still glorious. Walking through a paddock aisle as bays of '60s Formula 1 cars revved up on either side before heading to the track reminded me of that.

However, both the Revival and I have changed since those early days. My childlike ability to imagine has subsided. The event has become much bigger. The 'village' around the pit and paddock (including a make-do-and-mend tent, static aircraft displays and 'Earls Court motor show') has continued to eat up the grassy infield. This has necessitated a new pedestrian bridge just before Madgwick corner.

Another anachronism is the variety of food for sale; I wonder what 1950s' patrons would have made of loaded fries. And maybe it's just me, but there appears to be more 'brand activation' from companies nowadays. I try to ignore their modern display cars and marketing reps. I come to the Revival to escape that sort of thing.

Evolution on track

Revival grids have evolved, too. The blue riband Tourist Trophy Celebration no longer gets Ferrari 250 GTOs, presumably because they're too valuable, which breaks the time travel illusion somewhat. But is it better to have no Ferraris, and a less historically accurate grid, than a bunch of so-called continuation specials? I miss seeing the red vs British Racing Green of the Jaguar E-Types that graced Goodwood in the '60s, but maybe we should keep the true classics going for as long as possible first. The organisers remain keen to ensure each car's provenance; an interesting entry spotted this year was the Delage D6S-3L that finished second at Le Mans in 1949.

The Revival celebrates Goodwood's first operational period from 1948 to 1966, with cars, races and outfits dedicated to that time

In 2024, the Revival adopted 100 per cent sustainable fuel, which only releases recycled carbon into the atmosphere but keeps the familiar sounds and smells alive. Standing trackside, I certainly forgot the cars were using such 'modern' fuel on several occasions. Although it costs more, that's a small price to pay if it helps keep historic cars alive and kicking for longer.

Amazingly, Goodwood has now been holding races for nine years longer than it did during its original heyday. That's a measure of the success of the events held there. We are still over two decades away from the circuit's centenary, yet I can't help but wonder what such a Revival will be like. Can the event keep striking the difficult balance between authenticity and reality, which will only get harder as time progresses and the cars inevitably age? Will it need to take liberties in the cars it permits? By that point, in 2048, the availability of true period racers might be so low, their value so great, that recently built cars to original blueprints become a necessary evil. What concessions are we willing to accept to enable a snapshot in time to keep being reimagined?

Next gen

Many attending the early Goodwood Revivals were re-living the past. As a youngster, I could see that in people's faces and hear it in their voices. Perhaps they had attended races there when they themselves were young? As that generation moves on, the event evolves into something where its custodians have only experienced Goodwood in Revival form. I hope the authenticity and immersion don't get lost as we move further away from the days the Revival is trying to recapture. It's why proper historical research is so important; we owe it to younger generations to get it right.

Many things have changed at the Revival over the years, but pleasingly the racing hasn't. This year's event saw the likes of Jenson Button, Jacques Villeneuve and Jimmie Johnson tame their time-honoured Jaguar E-Types and AC Cobras in sideways rain. When I attended on Sunday, there was also an epic three-way fight for the lead in the bike race, and an amazing double overtake in the Sussex Trophy for 1950s' sports cars. All helped by Goodwood being one of the world's great circuits for spectating, its tyre barriers backing onto raised grass banks with unobstructed views of the track. That is the Revival I remember and very much want to experience for years to come.

I hope the authenticity and immersion don't get lost as we move further away from the days the Revival is trying to recapture

The silver odyssey

Mercedes is still struggling to find its form in the final year of F1's current rule set. Racecar spoke to the team's technical leadership to find out why

By CHRISTIAN MENATH

The 2025 season marks the end of an era. Since 2014, Formula 1 cars have been propelled by hybrid power units based on a 1.6-litre, turbocharged V6 with an MGU-K and an MGU-H. For a long time, it seemed as if this power unit era would be synonymous with Mercedes for, when the hybrid rules were introduced, the German manufacturer was a cut above the rest. Even a major change to the chassis rules in 2017 could not break the Daimler dominance.

However, everything changed with the introduction of ground-effect cars for the 2022 season. The Mercedes era came to an abrupt end. After eight consecutive World Constructors' Championship titles, it finished only third, behind Ferrari and a rampant Red Bull. From 2014 to 2021, the Silver Arrows won 69 per cent of all races but has won only seven per cent in the time since. Where the team once averaged 33.9 points per race weekend, has averaged only 19.7 since the rules shifted. The former top dog has seemed lost on several occasions during the four seasons of ground-effect F1 machinery.

In 2022, Mercedes started the season with an unconventional solution for its sidepods and stuck with it for a long time. In 2024, the team experimented with different pick-up points for the wishbones on the front axle and then, in 2025, completely lost its way with a new rear suspension.

McLaren's tyre temperature management has been key to its success this season, whereas Mercedes has struggled in this department with the W16, particularly controlling the rears

'Ultimately, when you do those changes, you don't optimise the time you have available to you, because you do something and then you come back, but you come back after some time. We never really recovered the gap to our competitors,' says deputy technical director, Simone Resta, who joined the team from Ferrari in October 2024. 'Sometimes you find exactly the right concept you believe is the best compromise in many choices and just keep chipping away and working on it step by step. It has taken us maybe a bit too much time to find a certain stable configuration just to keep chipping away, day after day, and improve the up-climbing development.'

Tyre trouble

Mercedes got off to a promising start to the 2025 season with the W16, George Russell finishing on the podium in four of the first six races. However, one problem from previous years remained: the rear tyres tended to overheat.

'You don't have to be on the inside of the sport to see that this is a championship that's being won on the basis of who is best at controlling tyre temperatures. That's clearly not us at the moment, but it does at least give a fairly clear signal as to where the effort needs to go,' technical director, James Allison, admits.

The Briton also clearly feels Mercedes is not alone in this regard: 'I think that if anyone in the team, in the pit lane, told you that they understood all these interactions, you would be able to see their nose growing. In any given year, there are people that do a better job with it and deserve to be lauded, and others that do less well and perhaps deserve sympathy rather than contempt.

'You don't have to be on the inside of the sport to see that this is a championship that's being won on the basis of who is best at controlling tyre temperatures. That's clearly not us at the moment'

James Allison, technical director at Mercedes-AMG F1 Team

There are a lot of things that none of the teams have full knowledge of; precisely how the heat flows around that part of the car is not particularly well understood.

'The behaviour of the tyre is something that is unique on the car, in that the rules of the sport specifically prohibit us from understanding the tyre as thoroughly as we might wish to,' Allison adds. 'The only place where we can learn about them in any empirical way is at grand prix weekends when we're trying to process the weekend itself. The limitations of that lack of control in the experiment are fairly evident because you can't control the environmental variables in the way you can when we're testing things on rigs.'

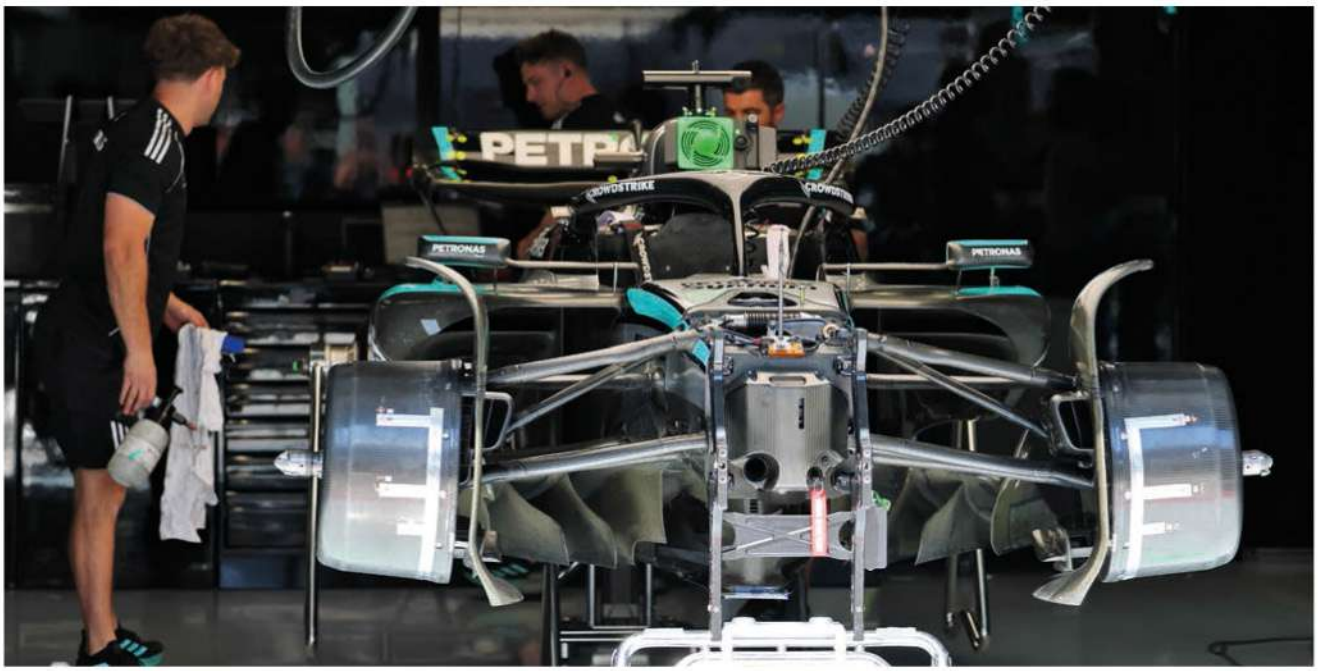
For Allison, the process has nothing to do with science: 'The sport wants it that way, and it certainly makes the sport more intriguing to have it that way. But it means that every single one of the teams out there, to some extent, is groping around a bit trying to make better sense of things they can only measure very imprecisely.'

Data provision

'This is partially correct,' says Pirelli's motorsport director, Mario Isola, when confronted with Allison's statements. In fact, the teams do not receive any tyres from Pirelli to carry out test bench runs; the regulations prohibit tyre test benches. 'On the other hand,' Isola continues, 'we agreed with the teams and the FIA to provide a list

Allison argues that the rules have prevented teams like Mercedes from fully understanding tyre temperatures

While Pirelli's Mario Isola is confident in the Milan firm's ability to provide the teams with the necessary tyre data



Mercedes has stuck with a pushrod front suspension layout for this final season under the current regulations, but it is the only team in the top four taking this design approach

of data to the teams at certain deadlines with information about static and dynamic measurements. There is a long list of data that we have to provide to the teams for any year of development, for any new product.'

The upshot is that, instead of each team putting the tyres through their paces on test benches, Pirelli does the work collectively for all of them. The Italian company has been F1's official tyre supplier since 2021 and will continue in the role until 2027 at least.

'We agreed that each team has the possibility to run eight hours of indoor testing in our facilities in Milan,' says Isola. 'It's the same amount of time for everyone, so it's fair, and they can choose any of the tests we are able to perform in Milan, and any of the conditions that are feasible with the machines we have. Our rig is quite new. We are using the newest we have for Formula 1, so I believe the data provided is good and reliable. Nobody complains about the quality of the data we provide.'

However, Allison has another issue with the tyres, this time with the product itself: 'There's been this rather bizarre idea of trying to get rid of tyre blankets because it would save a kettle's worth of electricity. The net result is that, as the sport has moved in stages towards a no tyre blanket future – which will never come – it has forced Pirelli to create rubber that is willing to say hello at lower temperatures, which means it also says goodbye at lower temperatures as well, making the tyres more thermally sensitive.'

The way the regulations currently stand, blankets are prohibited for rain tyres, but may still be used on slicks and intermediates, although the pre-heating times have been shortened and the maximum boot temperatures gradually reduced to 70degC.

Isola is quick to defend Pirelli's product: 'We are designing compounds that are able to work from 70degC up to the working range. I don't think that is a very low temperature. If you talk about soft compounds that are used on low-energy circuits, you can have 90-100degC [working range], so it's not a big difference compared to the starting point. There is the risk that the working range is too narrow, so we are working to widen it, but I don't believe starting at 70degC is really affecting that.'

Isola does, however, admit that there are problems with the data available. Specifically, he points towards the challenge of correlating what is found in the controlled conditions of an indoor test and what comes from the dynamic running of 20 cars on track. This will sound with aerodynamicists who have struggled to match their wind tunnel readings with real-world aero data.

'The only possibility – and that is what we are doing now, and I believe is quite a good system – is to use the rig to measure, with a specific methodology, the grip at different temperatures and characterise the compounds using this system,' offers Isola. 'The difference is that on the rig you don't run over tarmac, you run over a safety wallpaper that is a simulation of the tarmac.'

According to Pirelli's motorsport boss, there is a simple reason why the tyres still show thermal degradation: 'There are many reasons why tyres can be thermally sensitive, but it's not because of the blankets. We are working to make tyres that are in line with the targets defined in the target letter. At the moment, if I listen to the comments that I can collect, the tyre is too consistent. The level of degradation is low and can be managed quite well. So, ideally, we should have higher degradation to encourage teams to move to a two-stop strategy.'

Clearly, Mercedes is at loggerheads with the tyres. However, the rubber is identical for all 10 teams in the championship. The overheating problems are more symptom than cause. So, just what is the cause?

An adage in modern F1 says that downforce always helps. In the ground-effect era, downforce is also a function of dynamic weight transfer, and teams have designed their front axles with extreme anti-dive characteristics. This means the cars do not dive as much at the front axle when braking, so ground clearance is kept stabler.

For the W15 used in 2024, Mercedes' engineers planned a different wishbone configuration on the front axle and integrated two different pick-up points for the rear leg of the upper wishbone in the monocoque. However, when the extreme anti-dive variant did not seem to deliver the desired results, the drivers ran almost exclusively with the standard version. This experiment was abandoned in 2025.

Axle philosophy

Unlike Ferrari, Mercedes did not change its philosophy around the front axle for the final season of the regulations. Mercedes is now the only top team still using pushrods on the front axle (the others on the grid being Alpine, Aston Martin and Haas). For aerodynamic reasons, its immediate competitors are all using pull rods.

Allison says the team did consider this option but ultimately decided against it: 'I have little doubt there may be a better solution with the pull rod. But, as always, the question is one of, what is the best thing for you given where you are now?

Comparison between the W16's rear suspension in Miami (above) and the following round at Imola (above right), where Mercedes brought a new system but integrated it with existing hardware

'You want to keep the rear axle low. This whole generation of cars is about trying to keep the car in a very, *very* small ride height window because the downforce drops away very steeply as you come away from the ground'

James Allison

Running the floor as close to the ground as possible is only one part of the quest for downforce; Mercedes' suspension developments have been about delivering maximum downforce in all phases of the corner

We're always trying to weigh up where to spend our effort that we think that will give us the best lap time return. While the mouse trap might be slightly better with pull or pushrod, you'd only know if you developed both to a high degree and then compared the final resting state of both. We don't think there's enough in it to merit doing that.'

Nevertheless, changes were made to the front axle over the winter. The track rod was lowered one level to the rear wishbone leg for increased suspension loading and tyre wake control, improving airflow to the floor.

No major changes were made to the rear axle over the winter. After switching to a pushrod suspension concept in 2024, there was a lot of carry-over in 2025, though that was to change during the season. The first few races were promising, but the McLaren MCL39 proved out of reach. Mercedes reacted immediately and began developing a new rear suspension after the first race, which debuted in round seven at Imola.

Making big changes to the suspension during the season is a major undertaking. The fact Mercedes succeeded so quickly in this regard was because it did not develop a new gearbox housing. 'We tried our best to combine it with existing hardware,' says Resta. 'So the change on the carrier wasn't massive, just a minor modification.'

For example, the inner pick-up point for the top wishbone forward leg was lowered a few centimetres. 'It came across not as a clean solution,' Resta continues. 'You would have never done something like that starting from a blank sheet of paper, but it was the best compromise for us, for the time being.'

That, however, wasn't the problem. Russell complained about a strange feeling at Imola, even suggesting a track rod was broken. A week later, Mercedes reinstalled the old rear axle for Monaco. The team also opted for the old version at Barcelona, the last race of the European triple header.

A dangerous fallacy

Then, after disappointing performances and further problems with tyre temperatures, Mercedes reverted to the new rear axle for round 10 in Canada. There, Russell won the race, and Kimi Antonelli secured his first grand prix podium. The breakthrough seemed to have been achieved. A dangerous fallacy.

For in the races in Austria, Great Britain and Belgium that followed, Mercedes was far from the top three. What had happened?

With the new arrangement of the wishbones, Mercedes had shifted the rear axle kinematics towards anti-lift. In practice, this means the rear axle does not lift as much when braking, so the ground clearance remains more constant.

'You want to keep the rear axle low. This whole generation of cars is about trying to keep the car in a very, *very* small ride height window because the downforce drops away very steeply as you come away from the ground,' Allison explains. 'Although if you get too close, it starts disappearing. Most of the time you want to hold it pretty near the ground and not let it move very much from there. All these cars have a certain amount of pro-squat in them because that means as you come out of the corner, you put the power on, the rear drops down, which is exactly what you want

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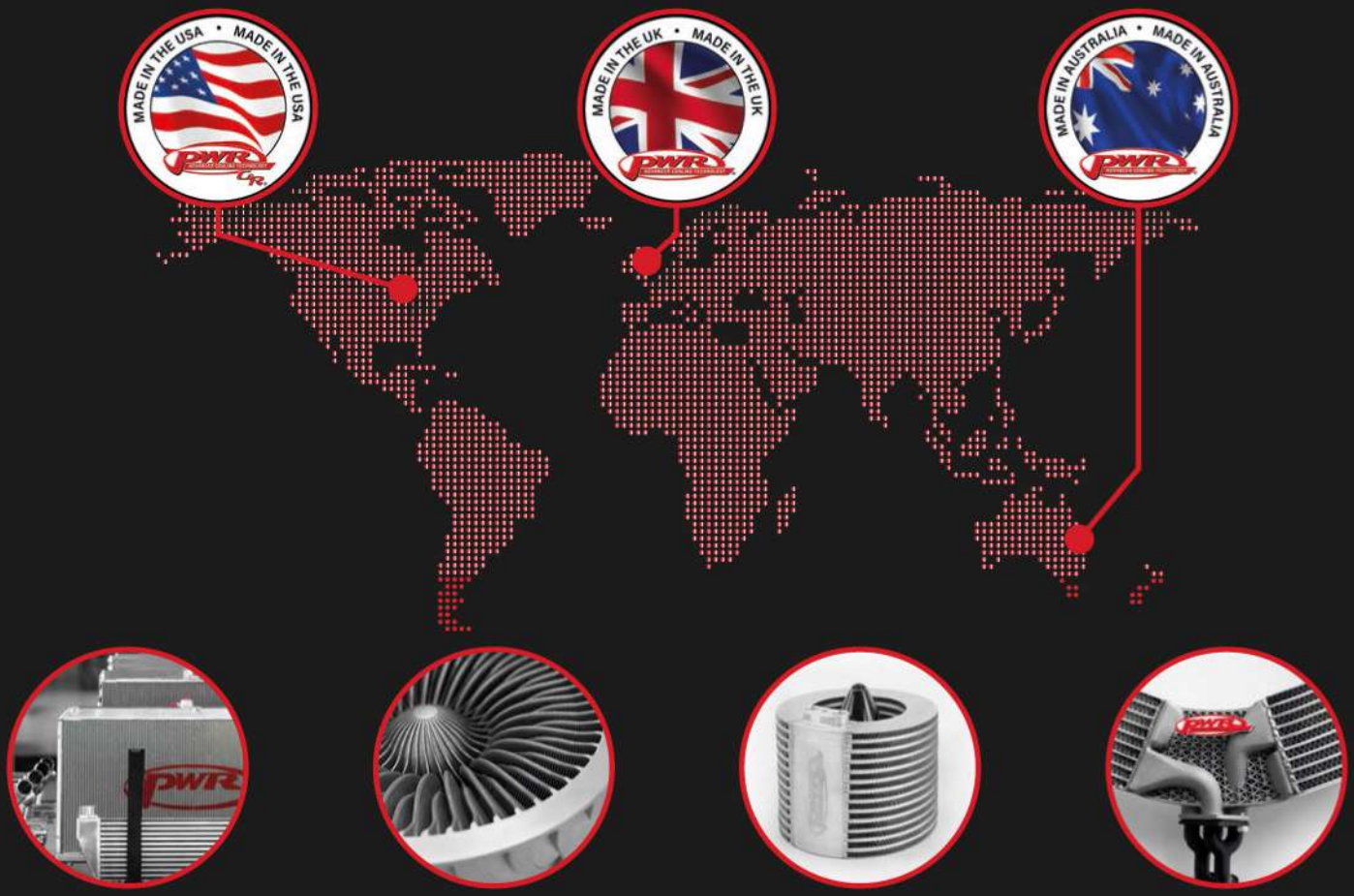

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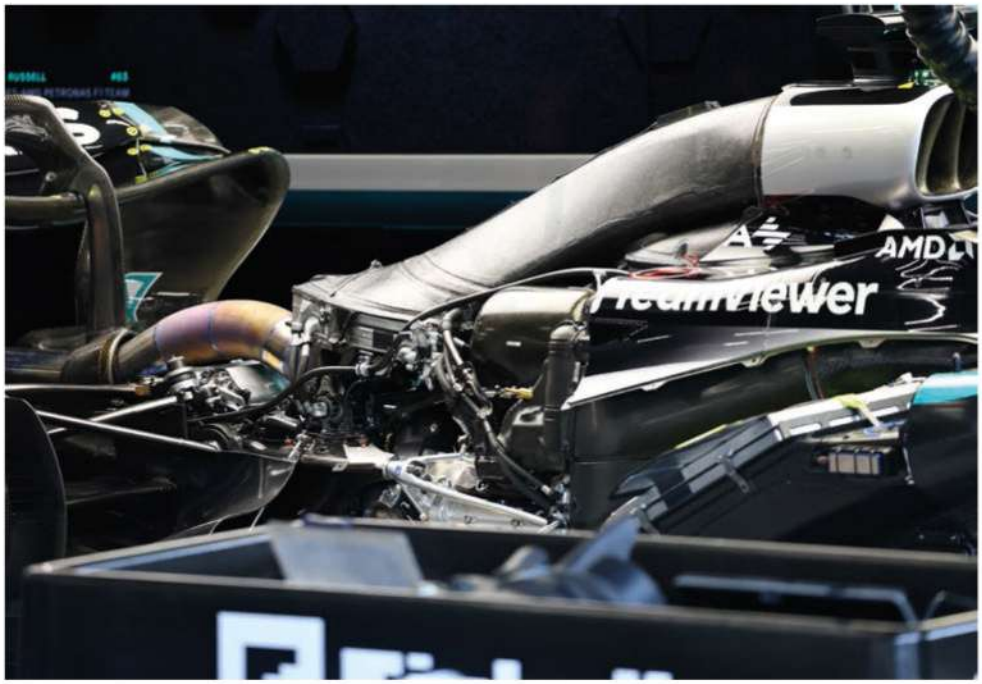
'Essentially, I think we made the car better in conditions like straight-line braking, but… it made the car worse in high-speed cornering and in combined braking'

Simone Resta, deputy technical director at Mercedes-AMG F1 Team

Mercedes was on song in Canada, as Russell beat Red Bull's Max Verstappen to the line by just 0.228 seconds, with Antonelli in third



Under the skin of the W16's engine cover. The engineers at Mercedes High-Performance Powertrains in Brixworth did a fine job in the early days of the V6 turbo-hybrid era, so will lightning strike twice under the new rules with increased electrification?

because that's where the downforce is and it helps you out of the corner. The trouble with pro-squat, though, is that as you hit the brakes, it does the opposite. So having a bit of anti-lift in there helps you deal with that.'

It definitely helped in Montreal. The Circuit Gilles Villeneuve puts more strain on the brakes than any other track on the F1 calendar. The long braking zones at the ends of the straights proved perfect for the new rear axle arrangement. 'Essentially, I think we made the car better in conditions like straight-line braking,' Resta agrees, though immediately adds, 'but, with some of the characteristics that we had to introduce, it made the car worse in high-speed cornering and in combined braking. That's the trade-off. I think it's a combination of kinematics and compliance of the suspension. They make it worse in those conditions.'

In the bin

Certainly, the drivers had less confidence in the new rear axle on high-speed circuits. Antonelli, with his aggressive driving style, suffered particularly from this. The Italian's style is to throw the car into corners, combining braking and cornering more aggressively than his teammate Russell. Ultimately, both drivers had problems with the set-up, so Mercedes reverted to the old version before the summer break and Russell promptly returned to the podium in Hungary. The farewell to the new rear axle was not an altogether friendly one: 'It will be ending up in a bin somewhere,' declared team principal, Toto Wolff.

The question is, why did it take Mercedes so long to realise the mistake? The update was used for five race weekends and, apart from the victory in Canada, there were two fifth places, one seventh position and, at Silverstone, only a 10th place finish for Russell. Apart from Canada, Antonelli did not score a single point with it.

From Imola to Spa, Mercedes brought a total of 12 further aerodynamic performance or track-specific updates. At least, a dozen updates were reported to the FIA, but Mercedes tends to be reticent with public declarations. The more innovations there are, the more difficult it is to isolate the effects of a single update. In addition, a technical directive came into force in Barcelona. Since round nine at Barcelona, front wings are no longer allowed to bend as much under load. All teams had to respond and reinforce their wings. The technical directive is likely to have slightly worsened the balance between slow and fast corners for everyone.

Did Mercedes suffer more than its competitors from the changes?

'Good question,' Resta replies. 'Of course, we cannot do any tests because it's not legal any more to run something like that. So, who knows? Maybe that has been a small drop for everyone. At the end, it's only relative and I don't know if it's been more for us or for other people. I believe it has been affecting many people by a different amount.'

As the European leg of the season concluded and attention turned towards the run-in of flyaway races, Mercedes was locked in a battle with Ferrari and Red Bull for second position in the table. Having previously been so used to winning, in the last four years it has become accustomed to taking victories on a more sporadic basis. It has also seen one of its power unit customers, McLaren, emphatically surge to the top of the order. That said, the challenging experiences of the ground-effect era are likely to have galvanised the clever engineers at Brackley and Brixworth. How Mercedes digests and applies the learnings from this relatively tough period of its F1 history will no doubt have a significant impact on how the team fares under the new regulations in 2026.

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Williams rising

The British squad has enjoyed its best season in years, but will its strategy pay off in 2026?

By DANIEL LLOYD

Williams's transformation from sporadic point scorer to podium finisher is remarkable because of how quickly it has occurred. The Grove-based team had been largely underwhelming in the first three seasons of the ground-effect rule set, which started in 2022 and concludes at the end of this year. Prior to the current season, its best result in that regulatory era had been seventh. However, in 2025, it has equalled, or matched, that result eight times, including a third place for Carlos Sainz in Baku.

The team exceeded expectations by leapfrogging the teams it had spent prior years trailing, and breached the 100-point mark for the first time since 2016. Williams scored 84 points in seven years (at 149 grands prix) but needed only 16 races to surpass that amount this year. The numbers clearly illustrate a team on the rise, whose management is driven to make it a championship contender again.

Resource management

Such a large turnaround in fortunes from one year to the next might give the impression that Williams made a radical departure in its car design with the FW47. However, that is not the case. The FW47 is an evolution of the FW46, which finished ninth in the 2024 World Constructors' Championship. It even uses the same carbon fibre monocoque. Some modifications were made to the chassis, to accommodate new aerodynamic surfaces, but otherwise it was a major carryover part, which saved on time and resources.

Williams had already embarked on a big weight saving programme in its design of the FW46 chassis. That, ironically, put pressure on the lead time of other components, making them overweight and the car slow at the start of the 2024 season. Once the excess mass was shed, though, the team had a monocoque around which the FW47 could be developed. The car started 2025 below the 800kg minimum weight (F1 cars may be underweight provided they run with ballast).

Williams scored points in five grands prix last year, but the 2025 season has been a transformation, with the team racking up more than 100 points with seven races still to run

'Given the change of regulation that's coming up, we continued our development with the current car,' says Paul Williams, chief trackside engineer at Williams Racing. 'We had also brought forward some of the developments that we had planned for the 47 onto the 46 [such as] a new front suspension geometry, which we brought to Singapore.'

The main task in the first half of 2024, then, was to reduce the FW46's weight, while high attrition and a mid-season driver swap masked the true effectiveness of performance-seeking updates. It was a challenging year. That said, the team felt it had developed the FW46 into a workable platform by the time the season ended, laying solid foundations for what would become the 2025 car.

'Generally, the focus on this year's car has been total load characteristics, to try and improve our combined entry characteristics and our response in terms of yaw and certain wind behaviours'

Paul Williams, chief trackside engineer at Williams Racing

As Williams mentions, the FW47 front suspension was unrolled during the 2024 season. Other developments, however, had to wait until the winter, such as a re-packaging of the coolers to free up space around the upper body surface, which is important for controlling airflow to the rear. When the FW47 broke cover, it had a noticeably flatter upper sidepod surface, a lower and wider central cooling exit and a more convex lower section of the engine cover.

Total focus

'Generally, the focus on this year's car has been total load characteristics, to try and improve our combined entry characteristics and our response in terms of yaw and certain wind behaviours,' says Williams. 'The other area we struggled with at the start of the FW46 was weight. So, there was a clear focus from the team on mass saving, with this year's car running pretty much on weight all year.'

One substantial difference between the FW46 and FW47 is the use of Mercedes' 2024 pushrod rear suspension, which wasn't available for Williams to use on last year's car (though fellow Mercedes power unit customers, Aston Martin and McLaren, did have it). Mercedes provides the gearbox, and the suspension mountings that radiate from it, but Williams is responsible for the rods' aerodynamic shrouding.

The FW46 of 2024 (above) had a more pronounced, valley-like depression at the rear of the sidepod, while the FW47 (below) has a more consistent profile in that area

Rather than spending half a season dealing with the consequences of a late-designed car, the team could hit the ground running with its latest machine

Comparison between the FW46's rear suspension (above) and the FW47's (below), which was developed for the 2024 Mercedes. Williams has had to learn the system to extract the maximum performance available from it

'It brings a lot of set-up adjustability,' says Williams of the switch from pullrod to pushrod. 'So, we do benefit a lot from their development. But in some ways, you've got to complete the learning on that because we weren't there from concept phase. We get the end product, so we almost have to reverse engineer the learning and tool support for us to extract the maximum performance from it. That's something we've been working on.'

Turning heads

The Williams FW47 turned heads at pre-season testing in Bahrain when Sainz posted the fastest lap time. It was a far cry from the same event 12 months prior, when the FW46 only rolled out in Bahrain the day before testing started. This time around, Williams was able to hold a proper launch event at Silverstone where a shakedown took place. Everything about the FW47's arrival was calmer and less rushed. Rather than spending half a season dealing with the consequences of a late-designed car, the team could hit the ground running with its latest machine, and that's exactly what it did.

Both Williams drivers reached the third session of qualifying at the season opening Australian Grand Prix, Alex Albon taking sixth ahead of both Ferraris. Albon then gained a position in the wet race, banking more than half of the previous season's points haul in one go. Proving it wasn't a flash in the pan, Albon and Sainz both scored in China, Saudi Arabia, Miami, Imola and Monaco. Of note, Albon claimed back-to-back fifth places in Miami and Imola. Although Williams wasn't quite matching the points accumulations of McLaren, Mercedes, Ferrari and Red Bull, it quickly established itself in a strong fifth place out of the 10 constructors.

In our analysis of the FW46 last autumn, Williams' head of vehicle performance, Dave Robson, spoke about the team wanting to create a more 'universal' car that would be decent on all types of tracks but not especially suited to one at the expense of others. The run of good results early in 2025 suggests that goal has largely been achieved with the FW47, although it didn't give the full picture.

'I think in terms of our performance across a range of tracks we have improved, but it's fair to say we still tend to struggle in areas high combined loading corners,' suggests Williams. 'We saw at tracks such as Hungary, it tends to expose the car a little more. That, I think, is somewhat ingrained the car.'

The problem the FW47 has inherited from its predecessors is that it struggles through long-radius corners. This helped to explain why it struggled more at tracks like Barcelona and the Hungaroring.

'We have a car that does very well in straight-line braking and 90-degree corners,' relayed Sainz at the Italian Grand Prix in September. 'We don't like spending too much time in combined situations of entry and exit. We struggle very much with [a] through corner balance limitation, which hurts us in long corners.'

The Spaniard, who joined Williams from Ferrari in 2025, added: 'We have good ride, we have good braking capacity. So yeah, it's an interesting car. I'm discovering a lot of new things this year, having to adapt my driving style a lot to different limitations that I wasn't used to in the past.'

The team has been working to dial out the FW47's limitation in turns with slower, broader profiles, rather than accepting it as something incurable. It has also investigated the car's aero delivery and its positioning using the mechanical platform.

'An area of focus has been the electronic tools and how they complement the set-up,' Williams explains. 'Those two working in parallel is where we've made the most gains. Particularly the differential set-up and how you control that through cornering.

'On the flipside, Miami was a particularly strong track for us in the early part of the season, where we're seeing good low to high-speed balance. That middle sector in Miami was really good, and that's something this year's car has certainly improved on.'

Cooling complex

Mid-season, from round nine in Spain to round 14 in Hungary, was less prolific in results. Albon retired in Canada and Austria when his power unit overheated. The problem was on the cooling side, meaning it was not a fault with the Mercedes hybrid powertrain, and therefore something Williams needed to solve. 'The cooling system of these cars is incredibly complex,' says Williams. 'There's a series of air-to-water radiators and, internally, a series of heat exchangers to cool the various fluids. We had an internal system issue, which caused erratic behaviour that was compounded by the operational aspects we were putting the system through specifically to the race.'

Williams took a performance hit as it worked to solve a mid-season cooling issue that affected both cars and stunted its run of double points finishes. With that sorted, the team then had to work hard to regain the lost performance

By operational aspects, Williams is referring to specific race day running conditions that differ from practice, such as formation laps and pit stops. The initial containment of the issue saw Williams run the system about 5degC cooler than usual. This partly involved opening more engine cover outlets, allowing more hot air to escape at the expense of aero performance.

'We sat down and worked late into the night to pick it apart,' adds Williams. 'Off the back of that, we constructed a series of tests to try and isolate where the problems lay. At Silverstone, for example, we saw a different run programme [in practice], which replicated some of that race-style running. Before that, the initial containment was to run the system colder, which maintained control of it. Subsequently, having done those tests in the mid-part of the season, we have re-engineered a couple of areas having highlighted where the problem lay, which has improved the cooling performance. We can now start to regain some of the performance offset we've made by running it cooler.'

Sainz also encountered overheating issues around mid-season, although these were unrelated to those Albon faced. The Spaniard's car experienced a rear brake fire on the formation lap in Austria, preventing him from taking the start. 'We had an issue leaving the grid, and then some of the containments put in place under time pressure cascaded into the secondary problem, and ended up with the brake overheating,' reflects Williams. 'It's not really an inherent issue with the car. We completed a full review, as we always do, and I think in hindsight, the situation was containable.'

Williams has been relatively light on updates to the FW47 because it was one of the earliest teams to switch its focus over to 2026 car development. The early part of the season saw mainly circuit-specific changes, such as recalling the 2024 Monaco rear wing for the higher downforce and drag demands of the narrow street circuit. More fundamental changes included extending the chord of the front wing flap with a dipped profile (round three, Japan) to aid the load balance from front to rear, and a new geometry of the rearward flap and end plate (round nine, Spain), which coincided with tougher wing flexibility tests from the FIA.

Update programme

The exception to the light approach to updates was a set of four modifications brought to the Belgian Grand Prix in July. This came at an appropriate time because chasing teams like Haas, Sauber and Racing Bulls had started scoring bigger points and were threatening to capture Williams' fifth place in the standings. The update for Spa consisted of re-profiled floor elements to increase load at the front and edge of the floor, while improving airflow to the diffuser. The sidepod also received attention, in the form of a deeper undercut designed to improve flow distribution to the floor edge and spat region, and a new inlet geometry with a diagonal lip to support these revisions while maintaining PU cooling. Such modifications were identified, designed and signed off before Williams switched its development resources to 2026 at the start of this year.

'The large undercut is more for delivering flow to the edge of the floor, one of the key downforce-generating devices on the car,' says Williams. 'It's delivering a better-quality flow to the extraction winglets along the floor edge, and the rear corners around the spat region at the rear of the car. Although the undercut looks the most dramatic change, it's more the downstream effect and the flow conditioning to those devices on the edge of the floor that really bring the aerodynamic

'An area of focus has been the electronic tools and how they complement the set-up. Those two working in parallel is where we've made the most gains. Particularly the differential set-up and how you control that through cornering'

Paul Williams

Sainz has commented on the car being strong in 90-degree corners, but that is offset by a limitation through longer-radius turns

'Fifth is probably the ceiling of what we could have achieved under this regulation set. We're recovering from being behind conceptually'

Paul Williams

gains. It was more of an uplift in total load rather than any change in characteristics.'

Former Mercedes head strategist, and now Mercedes team principal, James Vowles, was clear about Williams' car development strategy when he said in autumn 2024 that the team was going to sacrifice its 2025 in-season development in favour of prioritising the 2026 car. This carried some risk, if the FW47 ended up being as uncompetitive as its predecessor and therefore required more updates. However, it was soon proven that the starting platform was strong enough to avoid that, even if the cooling issues and weakness in specific corners demanded some remedial attention.

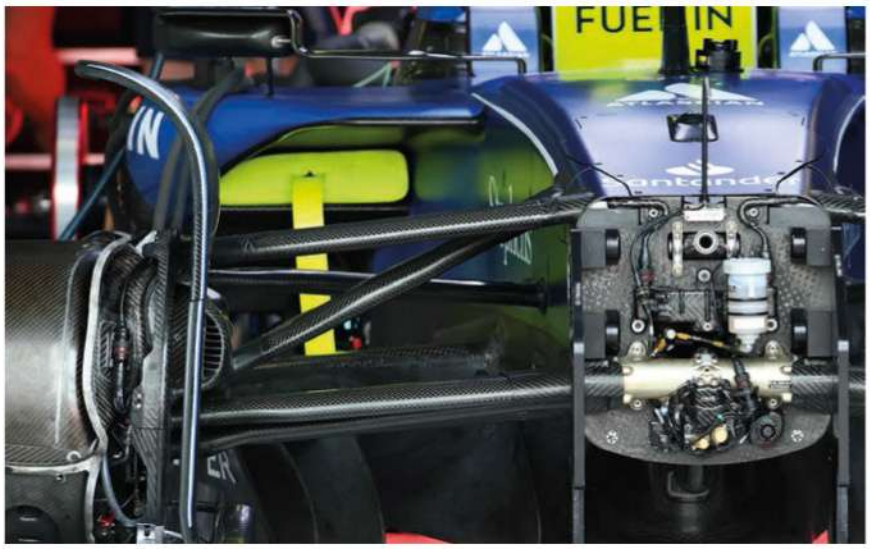
'It's been pretty clear that's the direction we need to take to make the most of the rule change,' says Williams, 'and to really make an impact if we want to move forward to the front of the grid. Realistically, the way this season has gone, we're very pleased with the performance of the car. Fifth is probably the ceiling of what we could have achieved under this regulation set. We're recovering from being behind conceptually, and we know it's going to be a tough fight to the end of the season to try and hold onto fifth place. How it's going to play out next year is impossible to know at this point.'

Bigger picture

If Williams does manage to keep hold of fifth position in the Constructors' Championship, it would be a big achievement for the team, though only a step in its aspiration to challenge for its first world title since 1997.

The team was purchased from the Williams family by Dorilton Capital in 2020. Vowles was hired as team principal in 2023 and quickly proved a good fit. He wasn't shy to expose the team's limitations from a resource standpoint, including the use of Excel spreadsheets for parts lists, which illustrated roughly where it was, and how far it needed to climb to reach where the owners wanted it to be. That climb, based on Dorilton's financial investment, is ongoing.

However, the measures to improve the background operations are already being felt on the engineering side. This has included a 'more data-led' engineering department with better simulation tools that are continuing to be upgraded.



Comparison between the FW47's sidepod inlet in the first half of the season (above) and the revised design introduced at round 13 in Belgium (below, image from Baku). The update facilitated a deeper sidepod undercut

'I think it's fair to say that we were a reasonably long way behind,' concludes Williams. 'It takes a lot of time to get those people and processes in place before we at trackside start to feel the benefits of that [investment]. I think we are starting to see that now, though, and it's only accelerating forwards as those changes come through, and we start to feel the effects of the people joining the team. We're only at the beginning of the journey, so it's going to be interesting over the next few months, into this new regulation set, as we can really start to flex that.

'On a more personal note, one thing James is very strong [with] is the team culture. There's no fear of failure. In fact, his aim is to uncover where we're weak as a team, and really expose those areas now, so we can deliver solutions and form more solid foundations when the car is quicker and we're at the sharp end of the grid.'

The team has rewarded that openness with results in the short term, and believe it will pay dividends in the long term too.

Paul Williams reckons this year's results with the FW47 have helped to validate Williams Racing's decision to push hard on its 2026 car development from the outset

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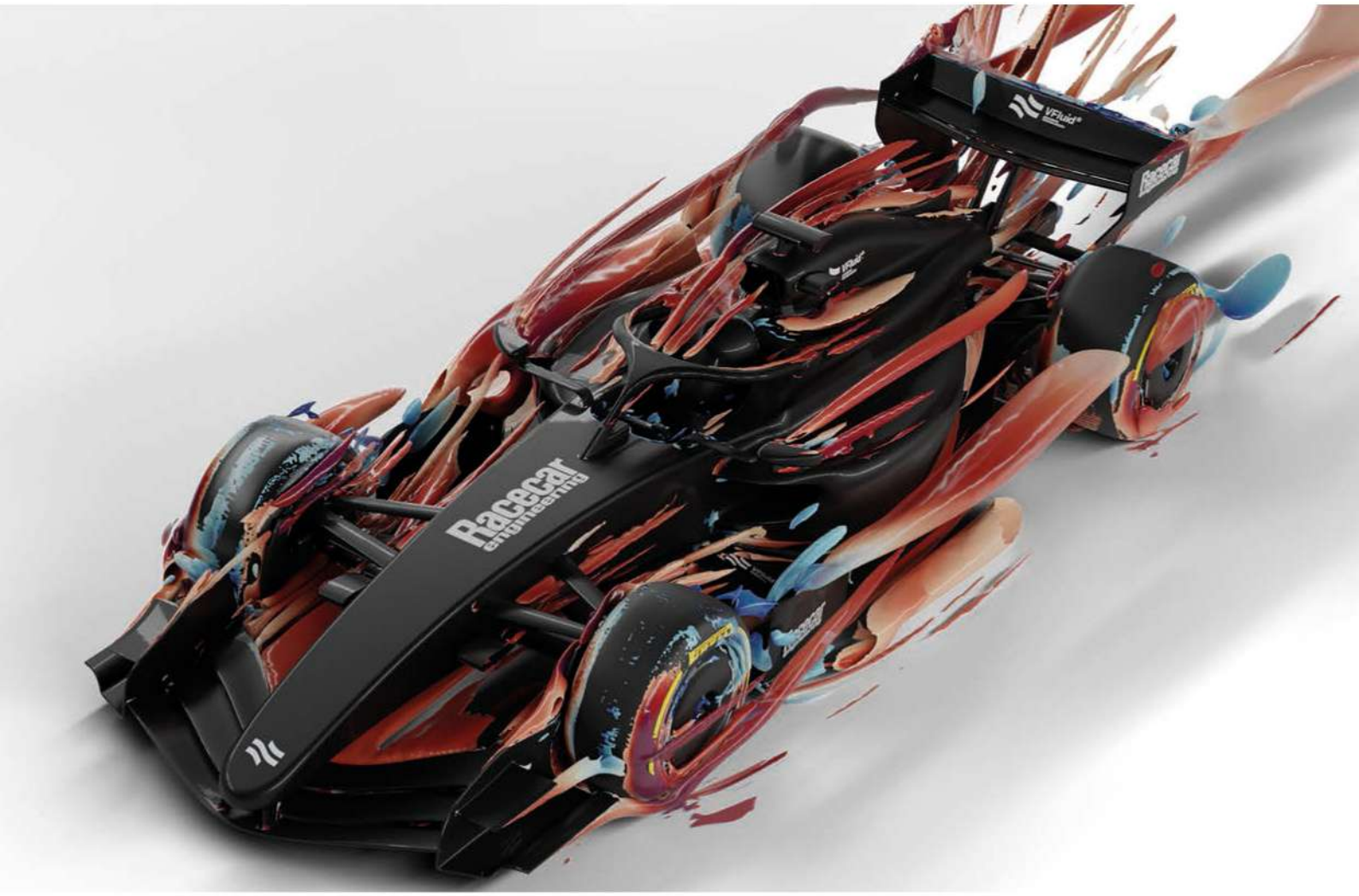
Carte blanche

What we can learn from aerodynamic mapping of a representative 2026 F1 car

By ADRIAN VILLAR and JAVIER MAYORDOMO, VFLUID ADVANCED TECHNOLOGIES



With a view to understanding the 2026 aero sensitivities, a CFD model has been created, here looking at the vortical structures around the Racecar Engineering model: Fig 1

When performance figures are published, they're often reduced to single metrics. This car generates x newtons of downforce. Or its drag coefficient is y. Useful for marketing departments, perhaps, but in engineering terms, such numbers are dangerously incomplete. Real aerodynamic performance is not defined by a peak coefficient; it's defined by behaviour, such as how a car generates load, where it generates it, and how consistently that load is delivered as the vehicle's attitude changes.

A car might produce an enviable peak downforce in CFD or wind tunnel testing, but if that performance evaporates under yaw, pitch or crosswind, it's irrelevant on the racetrack. It's the difference between a car that behaves across a season and one that only performs on certain tracks; between a chassis that allows drivers to push to their limits, and one that forces them to fight its instability every lap. In short, it's the difference between a midfield car and a championship contender.

Driveability wins

In engineering terms, this is driveability; the ability to extract performance across different circuits, conditions and driver styles. In *Racecar* V35N9, we highlighted how Racing Bulls shifted its 2025 development priorities towards this very principle – balancing the car not just in straight-line CFD runs, but through corners, off-centre load delivery and across steer, roll and ride height variations. Backing up what we've just said, the team's chief technical officer, Tim Goss, summarised it such: 'That all comes down to the driveability of the car.'

In other words, peak performance might make good headlines, but it's consistency that wins titles.

Vehicle dynamics departments often get the credit (or blame) for driveability, but in modern motorsport machinery, especially in Formula 1, aerodynamics dominate the performance envelope. However, aero load isn't fixed, it's a moving target, constantly

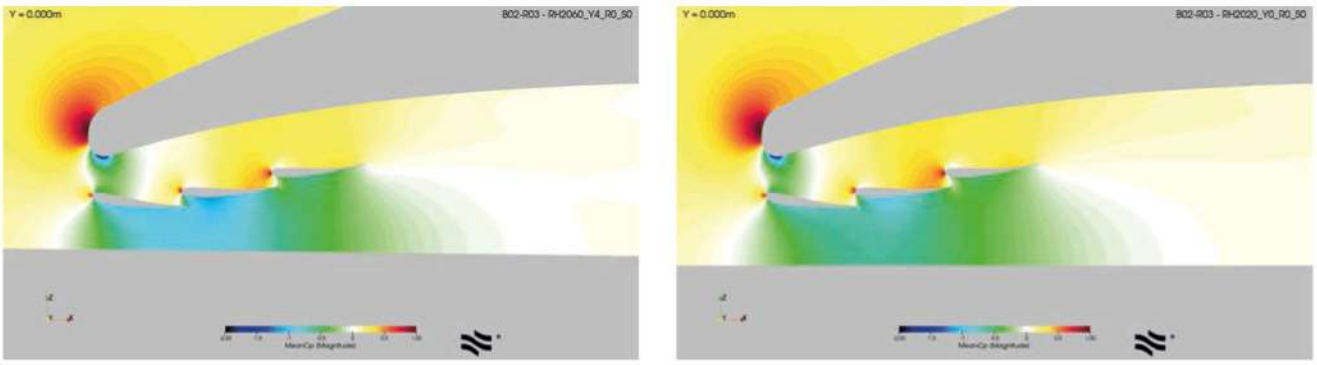


Fig 2: Pressure coefficient under the front wing at Y=0 plane

shifting with wind conditions and vehicle attitude: pitch, roll, yaw and ride height.

Take a representative lap around any modern F1 circuit. When is the car truly flat and steady? Almost never. Even with ultra-stiff suspension set-ups, the car is constantly pitching under braking, rolling in corners, yawing through direction changes and compressing through kerbs. Every one of these movements changes the aero loading, and not in a linear way.

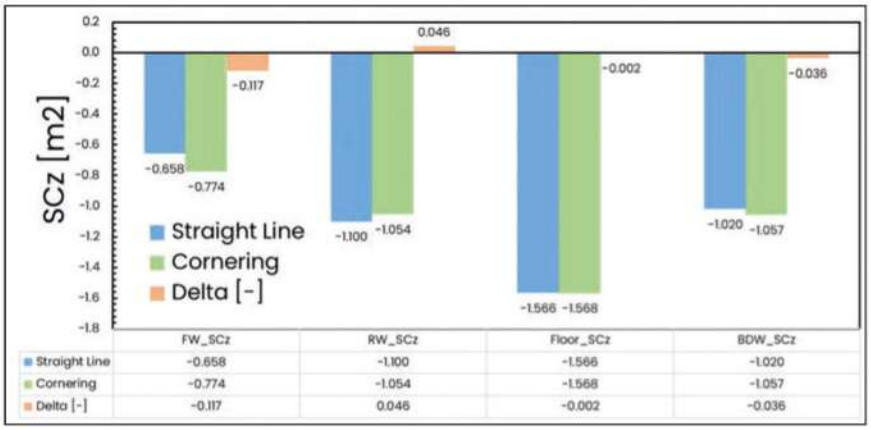
Attitude effect

Modern F1 cars operate fundamentally in ground effect. That means aerodynamic performance is directly tied to ground clearance. The problem is that not all devices respond equally to this proximity.

The front wing, mounted just millimetres from the track, benefits strongly from ground effect, producing much higher efficiency than the rear wing, which is elevated well above the floor. As the car's ride height reduces, the front wing's load changes disproportionately compared to the rear, leading to a shift in aerodynamic balance.

Figure 2 shows the pressure coefficient distribution in the Y=0 plane of an F1 front wing. On the left, front ride height (FRH) is 20mm, rear ride height (RRH) is 60mm and yaw is four degrees (a condition we could associate with cornering). On the right, FRH is 20mm, RRH is 20mm and yaw is zero (a representative straight-line condition). Despite identical front ride heights, the pressure depression under the wing is markedly different in the two scenarios.

Modern F1 cars operate fundamentally in ground effect. That means aerodynamic performance is directly tied to ground clearance



	FW_SCz	RW_SCz	Floor_SCz	BDW_SCz
Straight Line	-0.658	-1.100	-1.566	-1.020
Cornering	-0.774	-1.054	-1.568	-1.057
Delta [-]	-0.117	0.046	-0.002	-0.036

Fig 3: Cz per element at straight line and cornering attitudes

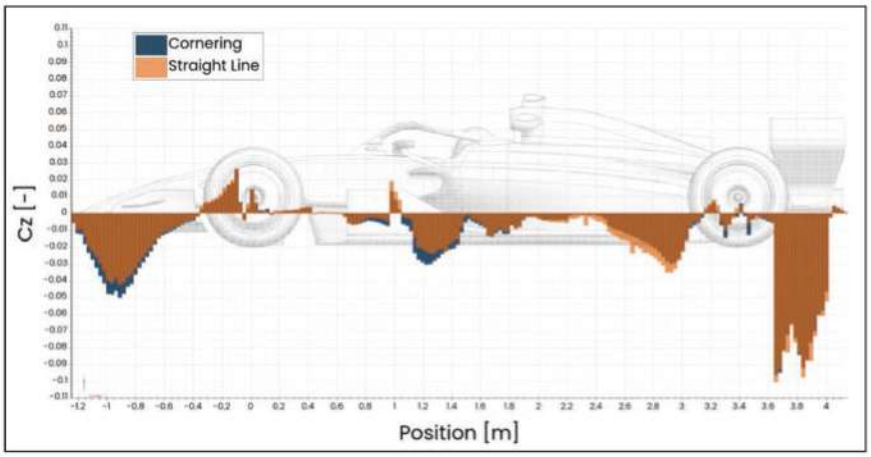


Fig 4: Cz distribution along the car for both attitudes, showing the forward shift in aero load

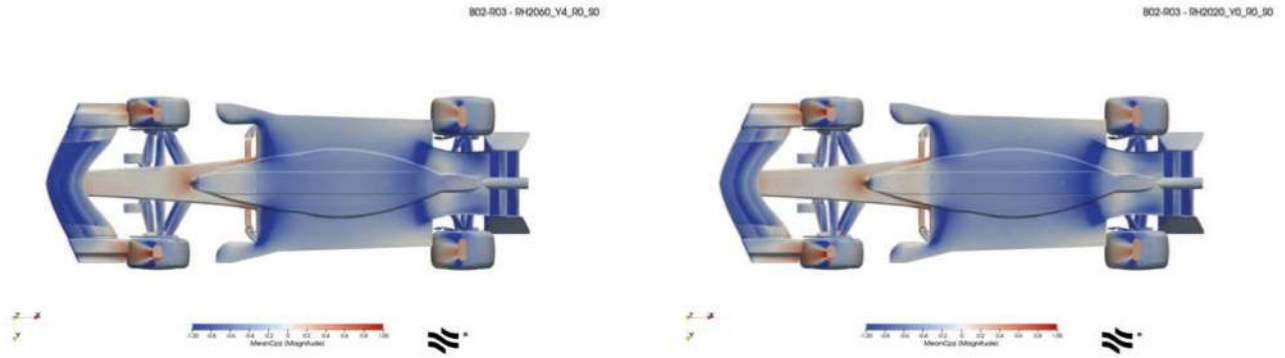


Fig 5: CpZ at the underfloor for cornering (left) and straight line (right) attitudes

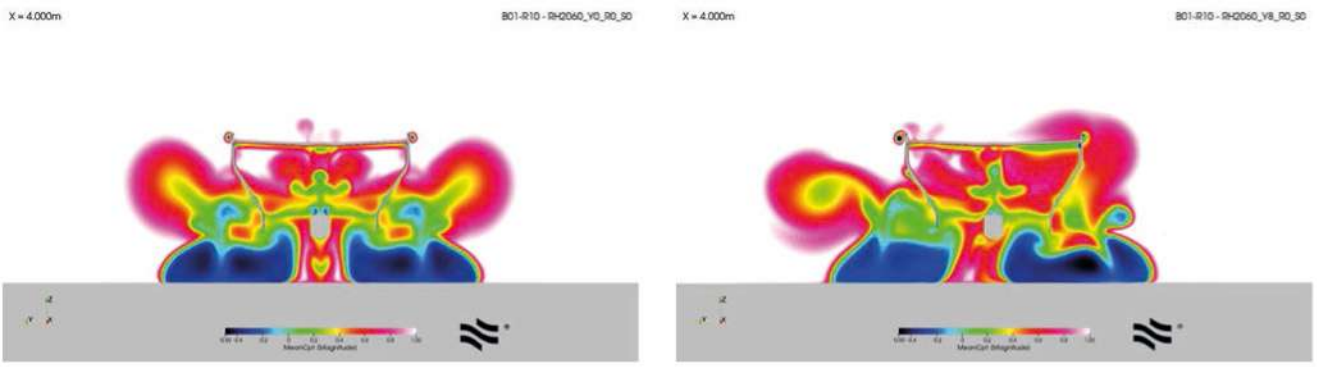


Fig 6: Total pressure coefficient at rear wing leading edge (front view)

Aeromapping is the thread that links theoretical performance to real-world behaviour. From set-up development to lap time simulation, this is the data we build cars around

Fig 7: Total pressure coefficient at Z=0.25m

This effect propagates into the load distribution across the car. In **figure 3**, we see how downforce changes element by element. The front wing gains 15.1 per cent, while the rear wing loses 4.3 per cent. The underfloor and bodywork remain essentially constant. The net result is a shift in aero balance from 28 per cent front to 35 per cent front – a substantial change for the driver.

Wake management

Another critical aspect of aero performance with attitude changes is wake interaction. In open-wheel racecars, wheel wake is the perennial enemy. Poorly managed, it disrupts the downstream flow, starving underfloor, diffusers and the rear wing of clean air. Consequently, teams dedicate enormous resource to so-called 'wake management', effectively trying to mitigate, rather than eliminate, the problem.

Again, though, sensitivity to attitude is key here. A beautifully managed wheel wake in straight-line CFD can quickly unravel in reality. Add a crosswind, or yaw the car into a corner, and the wheel wake can migrate inboard, contaminating the underfloor or disrupting the rear wing. And, of course, this happens at precisely the moment when downforce is most needed: when cornering.

Figure 6 presents an X-plane cut at 3.55m, aligned with the leading edge of the rear wing, showing total pressure coefficient. On the left, the car is running in a straight line; on the right, with eight degrees of yaw. The contrast is stark. The rear wheel wake, which remains clear of critical surfaces in the straight-ahead case, is now entrained directly into the diffuser and rear wing. The consequence is a measurable loss of load and efficiency. This example underlines a fundamental truth – flow structures are never static snapshots, but dynamic fields that evolve with vehicle attitude.

Infinite problem

When aerodynamic forces vary as a function of pitch, roll, yaw and ride height, and when those variables change continuously around a lap, the result is an effectively infinite matrix of aerodynamic states. That's not a manageable design space. Not directly, at least.

So, how do teams turn this complexity into actionable data? How do they capture, condense and optimise performance across the full operational envelope? The answer is aerodynamic mapping (aeromap for short).

At its core, an aeromap is a numerical and visual representation of how aerodynamic forces – downforce, drag, side force, aero balance and moments – vary as a function of car attitude. It's not just a spreadsheet of coefficients, though. It's the car's aerodynamic fingerprint.

Aeromapping is the thread that links theoretical performance to real-world behaviour. From set-up development to lap time simulation, this is the data we build cars around. As such, aerodynamic mapping plays a critical role in modern motorsport and, if you don't understand your aeromap, you are missing the biggest part of the whole picture. Here's why:

- **Performance optimisation:** Motorsport engineers choose the configuration that will give best overall performance for a specific track.
- **Set-up:** Understanding any sensitivities provides the fundamental information to choose the set-up of the car.
- **Energy management:** Balancing drag vs downforce to optimise efficiency – a key concern in F1 2026.
- **Driveability:** Ensuring the car will be predictable to *all* drivers and not perform inconsistently on track.
- **Design validation:** Engineers rely on aerodynamic mapping as a key input for lap time simulations.

Tools of the trade

Wind tunnel testing

Still the gold standard for aerodynamic mapping, the wind tunnel offers unparalleled repeatability. Whether scale model or full size, cars are swept through combinations of ride height, roll and yaw to capture how loads shift. Modern rigs even replicate steer, tyre squash and ground belt motion.

The cost of such precision is significant. A wind tunnel campaign requires access to advanced facilities, an accurate scale model

Figure 8: Vortical structures around F1 2026 car

When telemetry isn't available early in a car's development programme, educated guesses and legacy experience fill the gaps

Fig 9: Total pressure coefficient (Cp) at Z=0.25m

or prototype, equipped with sensors, flow visualisation tools such as PIV or robotic probes, custom part design and manufacture. On top of this, there's the logistics of transporting both the model / prototype and the engineering team to the site.

Computational fluid dynamics (CFD)

Aero mapping via CFD has exploded in both capability and credibility in recent times. With a similar procedure to that used in the wind tunnel, the car is simulated at a number of conditions to ascertain its performance in different scenarios.

Here, not only forces and moments are extracted at every ride height configuration; you also have all the data and visualisation capabilities that CFD offers. This provides a huge amount of information for engineers to better understand what is happening.

On-track testing

Despite these technological advances, the final word is still the track. At the end of the day, no one cares how good your CFD and wind tunnel data looks, because it's your results on track that matter.

Real-world mapping uses pressure taps, aero rakes, flow probes and telemetry systems to validate aerodynamic models in actual operating conditions. Of course, on-track mapping requires a real car and, in the case of F1, by the time teams have one, it's usually too late for major design changes. Secondly, track data is messy. Countless variables can be measured, but almost none can be controlled. Finally, in today's F1 rules, testing opportunities are so restricted that every lap is at a premium.

Because of all the above, on-track mapping is primarily used as a validation tool; a way to ensure you can trust your CFD and wind tunnel results. So, while track data is noisy, dirty and imperfect, it remains irreplaceable.

The most reliable aero maps come from blending all three of the above tools: CFD explores, the wind tunnel refines, and the track validates. Correlation between them is what turns data into knowledge.

Aeromaps must reflect how the car is actually used on track. That means choosing test points that mirror the car's real operating envelope. The ideal case for this is telemetry-driven mapping, where logged data reveals common ride heights, yaw and roll angles. Engineers segment this into power-limited (drag sensitive) and grip-limited (downforce sensitive) phases and then apply statistical weighting to produce a map that predicts lap performance, not just a single design point.

When telemetry isn't available early in a car's development programme, educated guesses and legacy experience fill the gaps. Sensitivity sweeps of yaw, roll and ride heights remain essential to capture the car's behaviour.

Map fidelity

A dense map is not necessarily a good map. The fidelity of the aeromap is not only about how many points are tested, but also about how well they cover the operating envelope of the vehicle. The data may need to be interpolated using polynomial fits or, in more advanced frameworks, machine learning (ML) or artificial intelligence (AI) models.

If polynomial fitting is used, the data set should be carefully structured to avoid gaps or clustering that could lead to poor curve fits

or numerical instabilities. In this context, it is often better to have a balanced and symmetric distribution of points.

For ML or AI-based approaches, the philosophy changes. The priority shifts towards collecting as wide and uncorrelated a data set as possible. The goal is to populate the full matrix in a way that captures both common and edge-case behaviours.

Ultimately, the mapping strategy must match the intended application. For fast simulation runs, a clean 4D fit works, but for real-time prediction, or AI-driven set-up optimisation, you need access to a full behavioural data set.

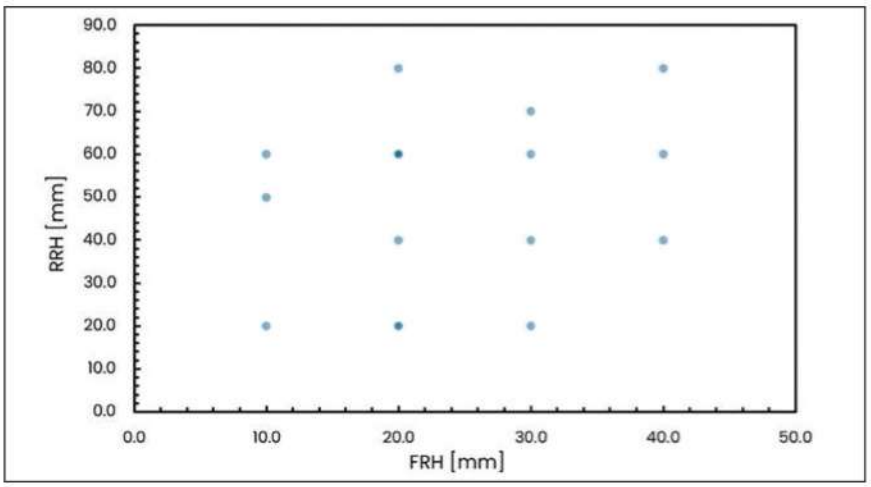


Fig 10: Aeromap sampling

F1 aeromap example

To illustrate how aerodynamic mapping feeds into car development, we've built a simplified, CFD-based aeromap for a 2026-spec F1 car. Of course, without access to real-car data, it's an 'educated guess', rather than a fully validated data set, but it highlights the kind of insights engineers extract when turning simulation into set-up guidance.

The weighted results put this car at roughly CdA 1.11 and CzA –2.47, giving a lift-to-drag ratio (L/D) in the 2.2 range. That's competitive for a first-pass concept, especially as this is a clearly under-developed car compared with what teams will bring to the track in 2026. As noted, though, the real value of the aeromap is not in a single number, but in how the car behaves across its operating envelope, and where its weaknesses lie.

Looking at **figure 11**, we can deduce a number of things. At low ride heights, downforce (SCz) falls slightly, but drag (SCx) drops with it. That's a positive trade for straight-line efficiency. The total SCz variation across the map is about 0.35, roughly 14 per cent of overall load. That range is wider than ideal and could be tightened in future development. Higher rake angles improve overall downforce, and aero balance proves relatively insensitive to heave, but shifts noticeably with pitch.

The map clearly shows the downforce loss with increasing ride height is progressive, without the kind of catastrophic stall cliffs that plagued early ground-effect concepts. That suggests a fundamentally robust floor.

Aero balance is equally well behaved. The migration across the whole map is contained to less than 12 per cent, giving a predictable balance envelope. In racing terms, that's confidence the driver can lean on.

Yaw sensitivity

Yaw is where the story gets interesting. At eight degrees yaw, total downforce drops by just over nine per cent, with the rear wing carrying most of the penalty. The culprit is rear wheel wake, which contaminates the flow into the diffuser and rear wing. The greater the yaw, the larger the rear load loss.

The front wing, by contrast, remains impressively stable. The floor initially loses performance but recovers as yaw increases,

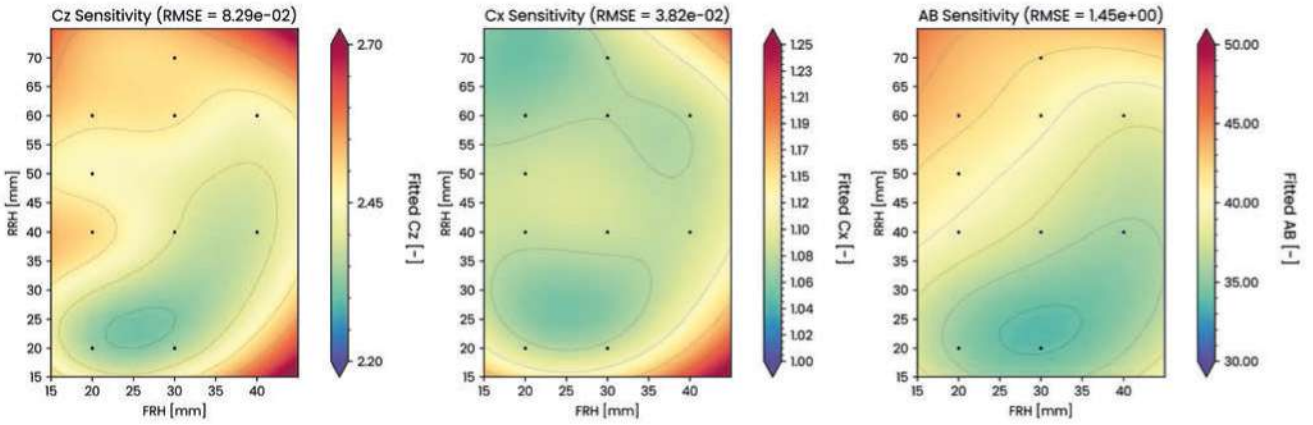


Fig 11: Example F1 2026 aeromap

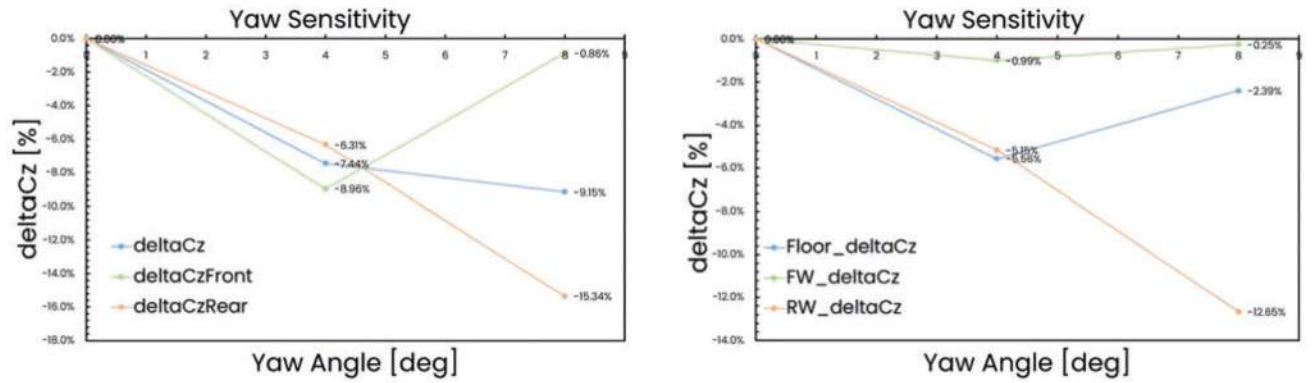


Fig 12: Yaw sensitivity plots for an example F1 2026 aeromap

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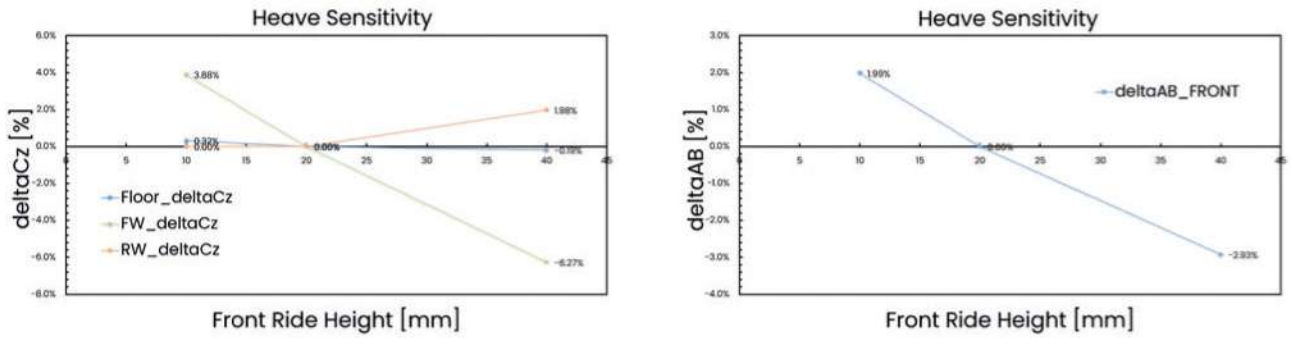

Fig 13: Heave sensitivity plots for example F1 2026 aeromap

a curious effect of how the windward-side sealing strengthens at higher angles. The net result is a slight forward aero balance shift (+3.9 per cent front at eight degrees).

The yaw sensitivity plots shown in **figure 12** underline the imbalance. At just four degrees of yaw, the rear loses almost twice as much downforce as the front. For engineers, that's both a warning and an opportunity, offering a clear target for development to stabilise rear load in yaw.

Heave sensitivity

Heave sweeps (altering the ground clearance at constant rake) presented in **figure 13** show the front wing is tightly coupled to ride height, gaining load as clearance reduces. The rear wing, however, loses a touch of performance, likely because the more aggressive front wing load starves it of clean flow.

The underfloor, meanwhile, remains surprisingly steady. That's good news. A stable floor means the car won't suffer wild swings in behaviour as it rides kerbs, or compresses under braking. Aero balance shifts forward as the car is pulled lower but, once again, the change is progressive rather than abrupt.

Given the 2026 diffuser regulations, it will be fascinating to see whether teams once again explore high-rake concepts, or whether the new geometry forces them towards flatter platforms

Rake sensitivity

Finally, let's consider rake. **Figure 14** tells us that holding the front at 20mm and raising the rear sees a steady increase in front downforce and a small reduction at the rear. Overall, total Cz rises with rake, but the aero balance moves forward significantly. That makes rake an effective tuning lever, but one that must be handled carefully to avoid turning entry stability into a knife edge.

Given the 2026 diffuser regulations, it will be fascinating to see whether teams once again explore high-rake concepts, or whether the new geometry forces them towards flatter platforms.

The data set shown here is deliberately coarse, just a few sweeps in ride height, yaw and rake. A real F1 team would go far deeper, populating the envelope with hundreds of points and then using machine learning to interpolate and predict behaviour across the full operating range.

Resource limitations prevented us from running a full resolution aeromap for this 2026 concept, and confidentiality prevents us from showing any real maps generated on current F1 projects. Nevertheless, what we present here is a randomised data set, representative of what a complete aeromap would look like using a machine learning approach, without giving away any sensitive detail. Food for thought, if you like, at an exciting time in F1's evolution.

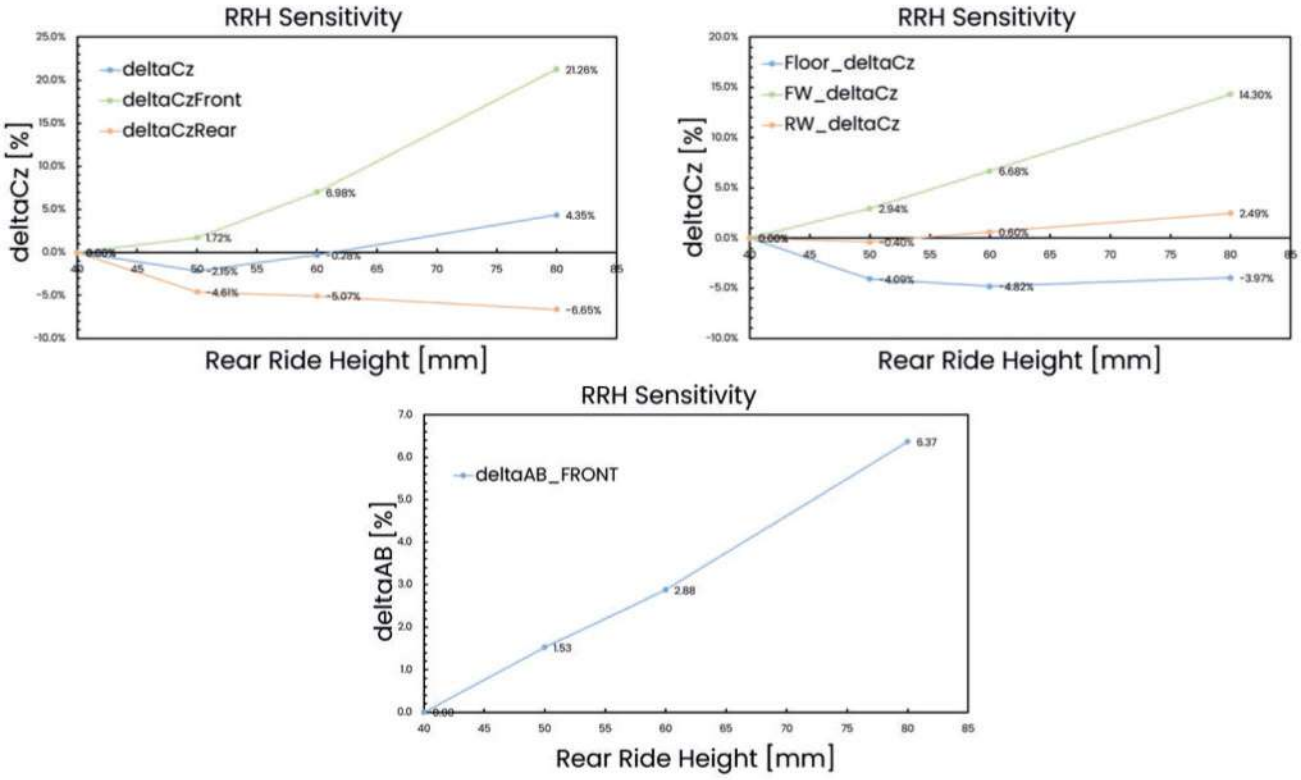

Fig 14: Rake sensitivity plots for an example F1 2026 aeromap

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A question of perspective

Toyota has had its worst season in sportscar racing for more than a decade but, says its technical director, that's nothing to do with the car, or the team

By ANDREW COTTON

Since the start of the FIA World Endurance Championship's Hypercar era in 2021, Toyota has been the standard bearer in terms of performance and team operation. In fact, the Japanese brand has pretty much carried the top class of the series since Porsche's withdrawal from the LMP1 class at the end of 2017, winning numerous titles up to and including the Manufacturers' Championship in 2024, and the 24 Hours of Le Mans every year between 2018 and 2022.

However, the 2025 WEC season has been little short of a disaster for Toyota. The team is not in contention for either the Manufacturers' or Drivers' titles, was not a threat to Ferrari at Le Mans, and in Brazil mid-season saw both its cars finish three laps down on the winning Cadillac V-Series.R at the end of a six-hour race. At time of writing, the team has not won a race in 2025, and the question on everyone's lips is, why?

On paper, it is easy to come up with reasons and find excuses. As the 2024 Manufacturers' champion, Toyota did not bring any performance updates to its car, while both Ferrari and Porsche did, despite winning Le Mans and the Drivers' Championship respectively. Toyota had designed a modified aero package but ultimately did not deploy it. In Hypercar, teams have to request performance updates, which are limited in number and must be agreed with the organisers.

A switch this year by the WEC from using the Sauber wind tunnel to Windshear discouraged many teams from introducing aerodynamic modifications, though by the end of 2025 all teams will put their cars through the latter facility in North Carolina.

Carrying compromise

The LMH-spec Toyota GR010 Hybrid was also designed to a different regulation set, one that included more front axle hybrid system deployment and, consequently, wider front tyres to help deliver that electrical power to the road. When the LMDh rule set was introduced in 2023, the LMH front hybrid system was castrated, only being available over 190km/h on some circuits. The system is

Toyota did not have its most competitive outing at Le Mans, where it finished fifth, a lap down on the winning Ferrari

Toyota Gazoo Racing

Floury says that teams can predict race outcomes when they receive the BoP table, but also warns that scrapping BoP would cause larger gaps on track and give manufacturers cold feet

'The absence of result is nothing to do with the execution, or driver performance. It is not the mechanics, strategy or anything. It has nothing to do with any of this'

David Floury, technical director at Toyota Gazoo Racing Europe

useful on the brakes, but cars designed to the original LMH blueprint, including Peugeot, carry inherent compromises.

By reducing power delivery at the front, Toyota and Peugeot were both effectively forced to change to a narrow front tyre, wider rear combination, which required a change in weight distribution, moving it rearwards to re-balance the car.

By contrast, Ferrari came into the world championship in 2023 with a new LMH prototype. The 499P was built to the updated, post-LMDh version of the LMH rule set and so, even though it still carries a front hybrid system, it was optimised from the start. Since its debut, Ferrari has continued with the same car, and the same drivers, building its database of knowledge so it is now prepared for most eventualities. It has grown stronger and developed its car, its systems and its team in the process to be at least as strong as Toyota.

Rules of play

'They designed their car two years later than we did, and the regulations were already in place,' notes Toyota's WEC technical director, David Floury, of the 499P. 'They were looking [at a] very different [rule set]. We have to live with that. It could be a performance differentiator but, if you look at the pure performance potential at the start of the season, we are looking strong. The absence of result is nothing to do with the execution, or driver performance. It is not the mechanics, strategy or anything. It has nothing to do with any of this.'

The Ferrari has long been subject to accusations of flexible bodywork at high speed, offering a top speed advantage, and consequently has had to modify its rear wing package in the last two seasons. It also modified its braking system to increase cooling, a performance edge that many have criticised as the car won Le Mans in 2023, 2024 and again this year.

Other manufacturers have questioned how the Ferrari could achieve the measured top speeds given the power levels and acceleration profile up to 250km/h. Wind tunnels have a maximum measured speed

of 250km/h, and speed behaviour above that can only be simulated, or witnessed in the real world.

It is also noticeable that Toyota has had numerous qualifying session and first lap lock-ups at the front, on cold tyres, while the Ferrari rarely, if ever, experiences the same issue. Toyota seems unable to match Ferrari's front-end characteristics in this iteration of the previously dominant car.

Running heavy

Weight is another important factor in the performance of the GR010. At the start of 2024, the car ran over its homologation weight limit in the opening races, and suffered with tyre wear and low performance as a result. This year, despite running lighter than in 2024, the new driver compensation weight, where lighter drivers carry ballast in race conditions, has meant the GR010 still runs heavy in race trim, which has once again compromised tyre wear. WEC rules limit the number of tyres a team can use over the duration of the race, which means longer tyre life is a necessity.

While all of this makes sense in theory, Floury rejects the majority of these arguments, suggesting there are other factors at play that are slowing the car artificially: 'For sure, the competition is getting tighter but, if you look at where we were in terms of pure performance at the start of the season, and where we finished in Qatar, Imola and Spa, and the fact that in at least two out of the three races we had by far the best execution of the race in the pit lane… But that is what you can extract when you put everything together on the race weekend, and we could not extract more.'

Don't mention the BoP

While he is not allowed to talk about BoP directly (the regulations ban discussion of the topic in the paddock on pain of sanctions from the FIA), it is clear this is one of the defining factors for how a race plays out. It is also completely beyond the control of the teams. The FIA and ACO send out the BoP documents to teams before the race, and then have an open discussion with them to explain their decisions. Manufacturers run their own simulations based on the figures and feed back to the group before a final table is released, yet teams are still not happy with the results the system creates.

'When you receive the [BoP] table, you already know what's going to happen, and this should not be the case,' said Floury at Interlagos in July. There, Ferrari, Cadillac and Peugeot were strong, but that was already a clear and expected pattern when the tables were released and before anybody had turned a wheel. The next race in Austin, Texas was wet, so the anticipated result didn't materialise, but that was an anomaly. There, the FIA countered that the BoP was not a defining factor in the outcome of the race, and that there were bigger differences between cars of the same team. However, among the manufacturers, there was a collective agreement that something needs to be done, though no agreement was reached on what that something should be.

'Collectively as a group, with the other manufacturers, and the FIA and ACO, I think it is urgent that we reconsider what we race for, and what we should target, because this season has not been good in this respect,'

The two Toyotas' positions at Interlagos in July (14th and 15th) were, says Floury, a foregone conclusion; Cadillac, Peugeot and Ferrari all performing as predicted from the BoP table

Despite running lighter than in 2024, the new driver compensation weight… has meant the GR010 still runs heavy in race trim, which has once again compromised tyre wear

Treacherous conditions in Austin saw an unexpected shake up in the order, but even that didn't help the results for Toyota

said Floury in Brazil. 'We urgently need to find a solution. Otherwise, I am sure it will have consequences.'

Manufacturer representatives, including David Salters from Acura (not currently in the series) and Cyril Abiteboul from Genesis (joining next year), met in Austin in September to discuss how to mitigate the BoP's impact. Suggestions included a new performance balancing system that would see each of the prototype manufacturers switching to a common platform with a rear-only hybrid system, and even abolishing BoP altogether. In that case, there was a suggestion that the homologation parameters (including weight, aero efficiency and power) be the sole defining point, as it was at Le Mans. There, however, Ferrari dominated in both pace and speed, and Toyota was clear that if there was no BoP, the GR010 and 499P would dominate.

Representatives then met with the FIA in Paris a week later to open a dialogue.

Development war

'BoP was part of the deal in Hypercar,' notes Floury. 'Before it started in 2021, BoP was part of the package and manufacturers committed to this. If we remove the BoP then it depends more on development. BoP is helping to keep the costs down, so we do not get back to a development war.

'[Relying on the performance window] has limitations. Secondly, if you remove the BoP entirely, it has to be accepted that it will bring significant gaps between the cars, and some manufacturers will struggle. When we had the homologation parameters, we saw those gaps. If we get rid of the BoP, we will not keep the same number of manufacturers in the next few years. It will drop pretty quickly because some will be stuck behind.'

The performance balancing system has evolved, and this year there was a new method altogether, which was described at the start of the year by the FIA and ACO, and was covered in *RE* V35N4. Essentially, the performance over the past three races would count, but it was for the FIA and ACO to manage the collection of information, and its findings were not shared with the teams.

For Le Mans, it was clear from the winter meetings between the governing bodies and the manufacturers that there would be no penalty for early season performance. For Ferrari, which targeted victory at Le Mans over any other race, this meant it could show closer to the true potential of the 499P in the opening three rounds of the year, and it was dominant in each of them.

However, the BoP tables can be compared year on year. The Toyota was 25kg lighter at the 2025 Qatar round than in 2024, with only slightly less power under 250km/h and significantly more power above that speed.

'If we get rid of the BoP, we will not keep the same number of manufacturers in the next few years. It will drop pretty quickly because some will be stuck behind'

David Floury

At Le Mans, it raced at the same weight, with more power below 250km/h and only slightly less over it, but had more energy per stint to play with. Yet, once again, it was not in the hunt for victory against the Ferrari.

Ferrari, by contrast, raced in Qatar 38kg lighter than in 2024, had the same power levels under 250km/h and only a small reduction over that speed. It also had less energy per stint to use, yet no one could get close to its performance in the 10-hour race. At Le Mans, it was one kilogramme lighter, had more power under 250km/h than in 2024, reduced power over that speed and almost the same energy per stint. The result was a resounding performance advantage at these two tracks.

Platform change

In terms of switching to a single platform with a rear hybrid system only, that is less realistic since Peugeot anounced it is already building its 2027 car with a front hybrid system, in line with the current regulations, but Floury also doubts this is the main problem with the WEC. 'Do we really think that two platforms is the main issue right now?' he asked. 'We have to prioritise things that are the right aspect of the championship. You could imagine a [BoP] system that can work more efficiently, but at the moment there is no draft of anything, so we cannot give an opinion. We need detail.'

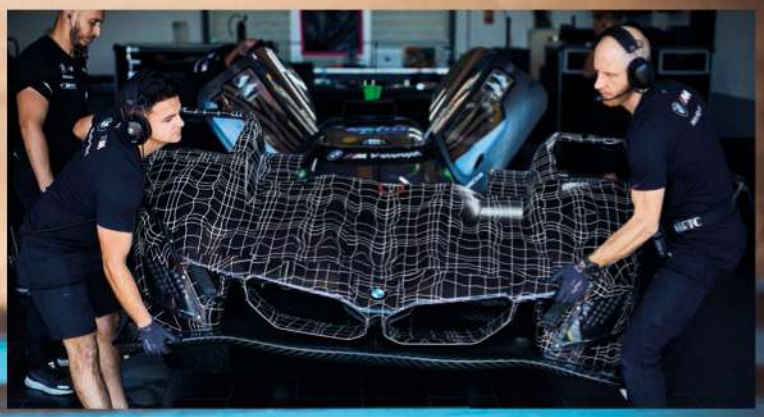
The 2025 6 Hours of São Paulo signalled a low point in Toyota's Hypercar programme. It finished 14th and 15th overall, three laps off the winning Cadillac and out of the points with both cars for the first time since its double disqualification at Silverstone in 2018. Then, in changeable conditions at Circuit of The Americas, the manufacturer had one of its worst ever races, again. Four-time WEC champion, Sébastien Buemi, has consistently complained of a lack of top speed, which prevents the GR010 from being able to manage traffic as efficiently as the Ferrari.

Something needs to change for Toyota, be it the BoP tables, or a new car. The team still believes the GR010 is fast enough and, in the spirit of the regulations, that is correct; the cars should be balanced without the need for updates. Yet with Ferrari so clearly ahead, Toyota must do everything it can just to keep up, and even more if it is to close the gap.

Joker in the pack

BMW has yet to win a race in the WEC, though the M Hybrid V8 has won three times in IMSA. BMW hopes that the new kit will help to deliver success for the Belgian WRT team, which has been confirmed to take over the US racing programme in 2026

Initial testing took place behind closed doors at Paul Ricard in France, followed by a run at Circuit of The Americas after the WEC race



BMW's signature twin kidney front grille has been significantly reduced in size in the update package

BMW has developed its LMDh Hypercar with an aerodynamic update package that is currently still under evaluation

By ANDREW COTTON

BMW has not had the most successful endurance racing programme with its M Hybrid V8, which made its debut in 2023. Although the car has won three races in the United States, including a one-two at Road America in August, its first FIA World Endurance Championship victory is pending. It arrived in the WEC one year after its US debut, so is a year behind most of its opposition in terms of development, and clearly still has a lot of catching up to do.

This is the second performance upgrade package BMW has introduced to the car, the first being to update the braking system for 2025, to give its drivers a more predictable experience. That, in turn, gave them more confidence on the brakes, more predictable cornering speeds and higher exit speeds.

Each manufacturer is allowed to make five updates within a five-year period. BMW resisted making a quick change after the first year as the car was far away from its full performance potential, and so BMW did not fully understand what it needed to adjust.

The second development has been an aerodynamic upgrade that has been on the design board for around 12 months. A new, smaller kidney grille is the most obvious change for the new kit, with an adjusted splitter that optimises airflow and new headlights, still in keeping with the brand's current styling cues.

The splitter is noticeably higher in the centre compared to the old version, suggesting more airflow under the car to better feed the rear diffuser. Floor design of the LMDh cars is strictly controlled, unlike the LMH cars against which it competes that have far more scope in the design phase.

The splitter is noticeably higher in the centre compared to the old version, suggesting more airflow under the car to better feed the rear diffuser

Shared platform

The BMW shares its platform with the Cadillac V-Series.R LMDh car, which has had considerably more success in the States and this year in the WEC, where it won the 6 Hours of São Paulo.

The Dallara chassis comprises the spine of the car and suspension, while the hybrid system is standard across all competitors,

including the gearbox from Xtrac, battery from Fortescue and motor-generator unit (MGU) from Bosch. Dallara worked with BMW on the development of its car's aero package which, along with engine choice, is the responsibility of the manufacturer.

One of the key targets of the update kit is to improve the raceability of the car, notably running in traffic. As the BMW is rarely out front, it needs to be able to follow cars closely to mount a challenge and, in the past, drivers have struggled in that regard.

'The main topic is driveability, the same as the evo joker with the brake,' says Andreas Roos, head of BMW M Motorsport. 'It is not about lap time, it's about consistency and predictability for the drivers. We realised, with the aero that we have, that the car is a bit sensitive on pitch, turning in and in traffic, and so this is where we worked.'

Performance joker

Even though this is a performance joker, it is not about improving lap time. Lap time is closely monitored and controlled through the Balance of Performance system, which means teams have to work around the areas the BoP doesn't see. That includes the braking phase, such as the braking effect of a normally aspirated car compared to a turbo, corner speeds and traction control at exit.

Cars are placed into a box on the aeromap of lift / drag (L/D), have power measured and noted, and the minimum weight of the car, the so-called homologation parameters. After that, weight, power and energy allowance are regulated, along with a top speed compensation, if required. Everything outside of these parameters is fair game, including software development and, in BMW's case, the cooling package.

The new kit has improved the cooling system of the M Hybrid V8, which should allow it to cope better in the hot races.

'It is not that you find four tenths of a second; it is the same principle as the regulation. If we reduced drag and increased downforce, it would be neutralised by the homologation BoP, so what we looked for was giving the drivers a more predictable car,' emphasises Roos. 'If it works out, we will see. Because in testing, the wind tunnel and CFD, you cannot simulate traffic and dirty air.'

Testing has taken place at Paul Ricard in southern France, and the revised car had its first public run at Circuit of The Americas in the days after the WEC race at the same venue. There, for the first time, it ran with others around it, allowing the team to more accurately simulate race conditions.

'Traffic is a part of it,' adds Roos. 'The competition is now so high you have a lot of bumper-to-bumper racing and if, when you want to make your move, you don't keep up in the corners, you struggle to overtake.'

The new aero kit has yet to be accepted by the governing bodies, the ACO and the FIA, but, if it is homologated, then BMW hopes it will be ready for competition at IMSA's 24 Hours of Daytona in January 2026.

On the table...

There is a proposal on the table for a rules update that would affect each of the LMDh manufacturers, including BMW. The suggestion is to allow them more freedom to develop their cars, though conversations have only just started and there is currently no consensus on whether they will be pushed through.

On the table is a change to the LMH aero sensitivity, to increase the gap between qualifying ride height and race ride height, considering the LMDh cars are particularly susceptible to the changes between those two sessions.

Another suggestion is to give the LMDh cars the same brake drum regulation as the LMH cars at the rear. BMW has already stated this could not happen for 2026 as such a change would require design, development and validation before it is introduced. However, it would allow teams to better manage temperatures within the wheel.

The LMH cars have the brake drums all round and, which allows for better temperature control, in turn leading to better tyre pressure control, particularly in the cooler temperatures at night at tracks like Le Mans or Daytona.

A third part of the proposal is to increase the power output of the hybrid system, making better use of the capability within the existing gearbox, MGU and battery architecture.

If implemented, these changes would come into play in 2027. Quite what this does to the joker system of upgrades has yet to be addressed.

'It is not about lap time, it's about consistency and predictability for the drivers'

Andreas Roos, head of BMW M Motorsport

The M Hybrid V8 made its debut in the 2023 IMSA Sportscar Championship, and arrived in the WEC the following year. BMW wants the new update to be ready for the '26 IMSA opener at Daytona

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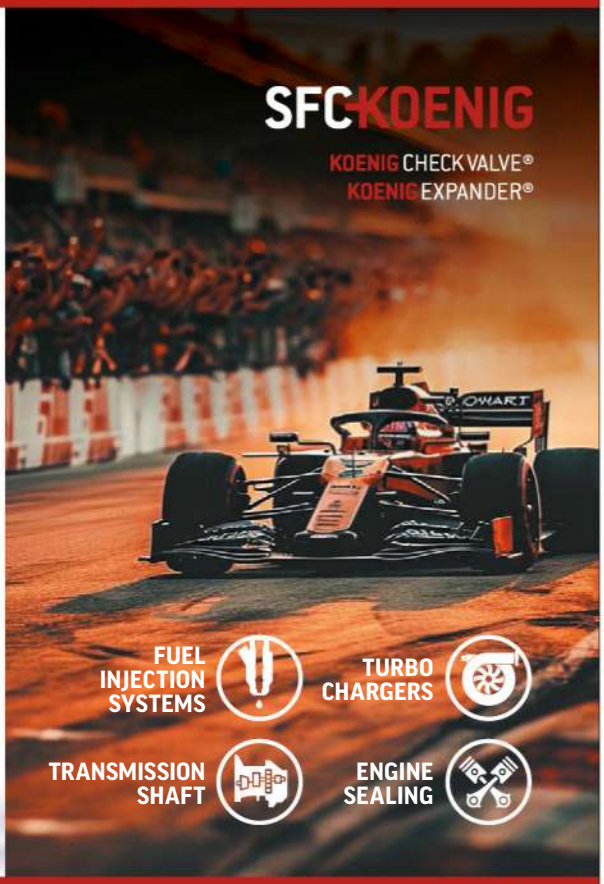

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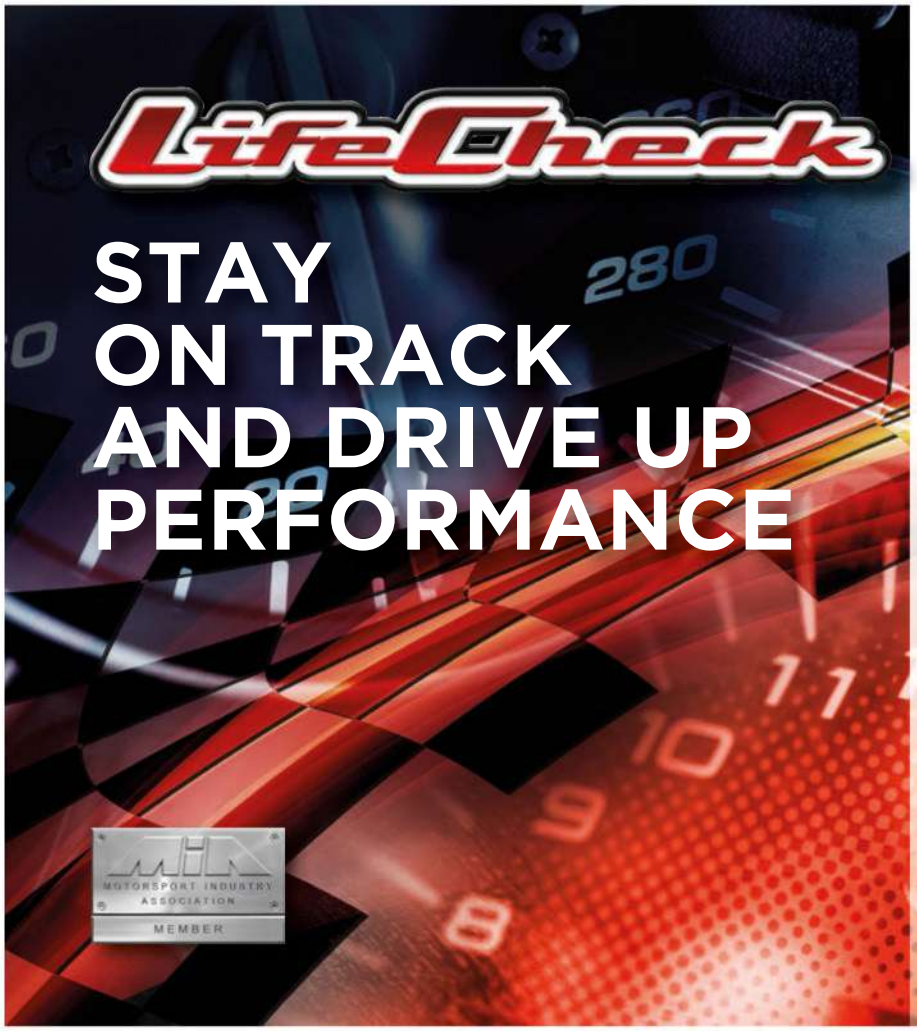

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Fieldwork

With powerful, hi-tech cars competing on rough rural tracks, Competitive Safari offers a formidable motorsport engineering challenge

By MIKE BRESLIN (Photos: Ryland Jones and Bresmedia)

Competitive Safari involves specialist vehicles competing against the clock on challenging terrain in a serious test of speed and durability

Sometimes, if you want to get across what something is, it's best to say what it's not. Take Competitive Safari, for instance. It's not a race, in that cars run individually against the clock. It's not a rally, in that drivers are free to go out on the course whenever they want to, within the overall timeframe. It's not a trial, in that any competing car should be able to complete the course. And it's certainly not a safari, though there might be the odd sheep nosing about.

What you're left with then is something very different to most modern motorsport disciplines, and perhaps the term that encapsulates it best is adventure. That said, it's also a huge technical challenge, featuring extremely fast, often purpose-built racing machines, running on often rough terrain.

A typical Competitive Safari event, or Comp' Safari as it's known, involves eight runs around a demanding stage, generally on farmland or woodland. For this article, we've focused on Safari Plus competitions run by the UK's All Wheel Drive Club (AWDC), though other clubs run similar events and formats.

Open competition

After the first drive through the course, competitors can complete subsequent runs whenever they want, and in that respect it's a little bit like an open pit lane track day, except every run is timed. The car with the lowest combined time over the required number of runs is the winner.

'Normally, it's a five or six-mile course,' says Tim Pink, competitions secretary at the AWDC. 'You usually get six and a half hours to do eight laps. It's out on the stage, come back, repair the car or fuel it up, and then go out again later. The course is open continuously.'

The stages are all designed to be driveable in fairly standard 4x4s. Indeed, Class 1 caters for close to roadgoing Land Rover Freelanders, though most cars that compete are heavily modified or bespoke, highly specialised vehicles, designed for strength and durability. Outright performance is important too, though there is a speed limit. Sort of.

The car with the lowest combined time over the required number of runs is the winner

Case study: Scott Benwell's Tornado Land Rover-Lexus

The largely self-built Class 6 Land Rover clone of Scott Benwell is one of the most sophisticated cars in the current field. The chassis is based on a spaceframe built by specialist 4x4 motorsport company Tornado, while Benwell's responsible for the rest. The bodywork is GRP, and the car weighs 1230kg.

In the rear sits a 4.0-litre V8 VVT-i from a Lexus LS400. 'We've got 345bhp out of it,' says Benwell, 'but torque is more important for us. She makes 420Nm of torque at 1800rpm and 520Nm at 5000rpm.'

This torque goes through a fully sequential 8HP gearbox, controlled by a system from Polish drift expert Turbolamik. It has eight settings, from fully automatic through sport auto' to full manual shift. It also has a launch control system. 'On the start line, I pull second gear. I'll hold the gear shifter in, which activates the launch control, and then just stand on the throttle. When I let the handbrake go, I'm away,' Benwell explains.

Putting the power down in the corners is more about the differentials: 'I used to have a locked diff' in the rear and torque bias in the front, but you couldn't turn it, because I was using the Milner race transfer box, which is basically a locked 4WD box. So, I put an open diff' in the front and then a Quaife LSD in the back and that is brilliant. When you come to a corner you lift off the throttle, that opens it up and then, when you deck it, it gets the grip.'

Marrying up the engine and the gearbox electronically has been a bit of a headache, but the car now uses an extremely sophisticated CAN bus system, akin to what you would find on a high-level circuit car.

Suspension-wise, it's a straightforward beam axle car with coilovers, though it has very progressive springs on the front, with three coils stacked on top of each other. 'We've got 60lb, 165 and then 200,' explains Benwell, 'and when you open everything up, these springs all come into play. And then we run hydraulic bump stops as well, for when it gets a bit too gnarly.'

The car's bypass dampers are by Fox. 'They have three stages, and you can adjust your bump and rebound. You can soften it right off, or harden it right up. You can quicken up your bump and everything, but generally the only thing I will do [during an event] is maybe play with the gas pressure, sometimes.'

Benwell's largely self-built machine might look like a Land Rover at first sight, but underneath the plastic facsimile 'shell is a spaceframe chassis manufactured by 4x4 motorsport specialist, Tornado

Benwell's car has this interesting triple spring arrangement at the front, which progresses through 60, 165 and then 200lb coils. The car also utilises Fox bypass dampers

The rear deck of Benwell's creation holds a 4.0-litre V8 from a Lexus, tuned to produce 345bhp and, more importantly, 420Nm of torque at 1800rpm, rising to 520Nm at 5000rpm

'With Safari Plus, our maximum average permittable speed around the course is 50mph,' explains Pink. 'If you exceed that, you're given the time for 50mph over the course. But we set the courses so that no one gets anywhere near that average. Normally, the average speed is around 40mph over the day, for the fastest competitors.'

Those fastest competitors will regularly hit speeds of 90mph, sometimes even topping 100mph on the straight bits, despite the very often bumpy courses. This is not that surprising when you see how open the technical regulations are and, while events might take place in farmers' fields, there is nothing agricultural about these vehicles.

'Our top cars are more like Group B rally cars than anything else,' says Pink. 'Four-wheel drive, 400+bhp, fully independent suspension, sophisticated dampers. They are bloody quick.'

Special forces

There are 10 classes in AWDC Competitive Safaris, most of which are based on engine size, including a turbo equivalency. The quicker cars are usually homebuilt specials and often Land Rover clones, with spaceframe chassis beneath GRP or carbon fibre bodywork and potent engines, often mounted in the rear. Recently, though, the scene has changed somewhat, with the emergence of UTVs (Utility Terrain Vehicles) from US manufacturers such as Can-Am and Polaris proving very competitive packages.

'Depending on the course, UTVs can be five seconds a mile quicker than the conventional cars,' notes Pink. 'A UTV ready for competition costs between £70,000 and £80,000 (approx. $95,000-$109,000), whereas a competitive, UK-built car could be around £150,000 (approx. $204,150) to build. There are people spending a lot of money on this.

'Our top cars are more like Group B rally cars than anything else. Four-wheel drive, 400+bhp, fully independent suspension, sophisticated dampers'

Tim Pink, competitions secretary at the All Wheel Drive Club

Case study: Brandon Barnwell's CRD Hayabusa

While many vehicles competing ape the looks of roadgoing cars, Brandon Barnwell's CRD is an unashamed racecar, with a Suzuki Hayabusa motorcycle engine built by RPE (Radical's engine division) mounted in the rear. This 1680cc powerplant revs to a screaming 14,900rpm, producing around 280bhp and 189Nm of torque in a car that weighs just 700kg, giving it a power-to-weight ratio of 400bhp.

As this vehicle is 2WD, it runs in Class 3, but with the engine mounted over the rear wheels, traction is not a major issue. 'In the front, there's the steering rack, the shock absorbers and the horn. Other than that, there's nothing,' notes Barnwell. 'So when it gets plenty of grip, it will wheelie.'

The gearbox is incorporated into the engine, as it was on the original motorcycle, while the limited slip diff' is a fully adjustable Formula 3-spec item.

The car was built in France, where CRDs are very popular in off-road events, and it's a full T45 spaceframe, braced to withstand the toughest conditions. 'This car is ultra strong,' says Barnwell. 'When you look at [the frame], every single bit, even if it is just holding a piece of bodywork, is triangulated.'

The spaceframe is clothed in carbon-Kevlar bodywork, so replacing large sections like the front end, or the engine cover, can be costly. Other expensive parts include the high-end Öhlins dampers – worth £14,000 (approx. $19,000) across the car.

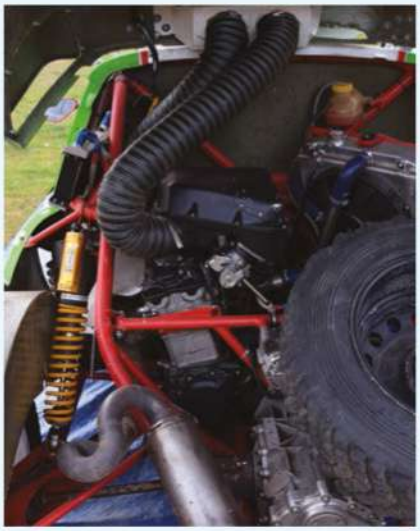
'I don't play with the dampers much,' says Barnwell, 'but if I thought it was kicking a little bit, I might take the rebound off a little, or something like that, which is very easy to do.'

There are no anti-roll bars and the spring is single rate, because the car is not heavy. With so little weight over the front end, it requires a power-on driving style to counteract the inevitable understeer.

While using the throttle will get the vehicle through a corner, for turn-in this car is one of a number of Comp' Safari runners that makes use of fiddle brakes, similar to the independent wheel braking system commonly employed on sporting trials machines and used on late 1990s McLaren F1 cars. Barnwell explains: 'The fiddle brake system doesn't just do a single rear, it does both brakes on each side of the car. Basically, there's a lever; you push it forward and it brakes one side of the car, pull it backwards and it brakes the other side. In practice, it works just like a hydraulic handbrake.'

Barnwell's CRD buggy is a 2WD-only Class 3 machine, and combines a sophisticated T45 spaceframe chassis with carbon-Kevlar bodywork. The ultra lightweight racer weighs in at around 700kg

To help the CRD through the turns, it has an unusual fiddle brake system that slows both wheels on one side of the car at a time, rather than just a single rear wheel as is more common



Barnwell's CRD packs the sort of 1680cc Hayabusa power unit that's more usually seen in a Radical circuit racer. This revs to 14,900rpm and produces around 280bhp and 189Nm of torque

UTVs have become popular in the sport in recent times. This GSR is based on a Can-Am Maverick and boasts a bespoke spaceframe chassis plus a body kit

'The UTVs are becoming more affordable all the time. From our point of view, we see UTVs almost as the future of the sport, because in two years' time there's going to be a glut of them on the second-hand market, which will make them cheaper to buy.'

Whether someone is running a UTV, or a more regular car, it will be beefed up to cope with the rough conditions. Spaceframes are often constructed from the best motorsport-grade steel, such as T45, with good design to ensure they're up to the job. Even the best of these cars, driven by seasoned drivers, take a bit of a beating, with Pink noting that the attrition rate for events is somewhere between 15 and 25 per cent, on average.

Yet while a tough car is vital, suspension is the area where much of the technical development in the sport takes place.

Many vehicles have expansive wheel travel – 60 to 70cm is not uncommon – and most of them, but by no means all, run quite soft set-ups. It's the dampers that are the key components here, with Fox Factory shocks popular, although other high-spec products from the likes of Öhlins and R32 are also used.

'If somebody gave me a few thousand to spend, I wouldn't spend it on the engine, I would spend it on the dampers,' adds Pink, who runs his own special, called a Mattserati, in Competitive Safari. 'If you're skipping, you're losing traction. Essentially, the wheels have got to follow the ground at high speed and at low speed, with your high frequency bumps and low-frequency bumps. A lot of people are now using bypass dampers and you're looking at £2000-£3000 per corner for those.'

However well impacts from the bumps and jumps are absorbed, the sport is still about speed, which means the engines are certainly not forgotten. Look around a Safari paddock and you'll see a remarkable variety of powerplants used in the discipline, from production V8s to motorcycle engines, as well as the more conventional 4x4 power units. Whatever the motor chosen, there's one characteristic that is especially desirable: 'Torque is important, and a flat torque curve would be ideal,' says Pink. 'That's why a significant number of people choose diesels.'

'Torque is important, and a flat torque curve would be ideal. That's why a significant number of people choose diesels'

Tim Pink

The power of two

Surprisingly, perhaps, considering this is the All Wheel Drive Club, two-wheel drive cars are allowed. These tend to be homebuilt specials, or Dakar-style off-road buggies, and they compete in Class 3, which is for 2WD only. One of the advantages they have, beyond generally carrying less weight, is they don't need the complicated differential arrangements that are a feature of the 4WDs.

Case study: Shabs Piercy's Can-Am Maverick X3 UTV

Running in Class 5A, Shabs Piercy's Maverick is prepared by UTV specialist, Team Synchro Racing (TSR). While it has not had a complete frame swap – something that is common with UTVs in this discipline – it has still seen a great deal of metalwork.

'From factory, they come with a roll hoop, not a 'cage,' notes Piercy. 'The 'cages put on these are designed properly, tested and then homologated by Motorsport UK. I know they work as I have thoroughly tested it myself!'

CDS forms the 'cage structure, rather than a more exotic material like T45. 'The weight gain on a 'cage this size isn't massive, versus the cost of it. The car weighs about a tonne, give or take a few kilos, so it wasn't worth doing, especially with off-road stuff. Let's say the weight difference was a kilo, I can pick that up in mud on a lap.'

The frame is clad in a mixture of factory plastic panels and aluminium sheet, fabricated by TSR into wheelarches and a roof, the latter incorporating an inlet for the radiator, which is rear mounted, along with the engine.

That power unit is a turbocharged, three-cylinder, 900cc Rotax producing 195bhp. Remarkably, at time of writing it had over 2000 race miles on it. 'It gets wrung to death every event,' Piercy says of the largely standard unit. 'It doesn't get treated nice, apart from servicing and general prep, but I've never had it apart.'

The Maverick is belt driven, so the transmission is variable, like a CVT, which means there's no gear selection to worry about. Piercy says the belt helps the engine 'spin up very quickly,' with no transmission lag.

The electronically-controlled front differential is standard Maverick, and the locked rear differential is incorporated into the transfer box.

Fox shocks work together with Eibach springs. 'They are internal bypass shocks, so they're fully adjustable for compression and rebound,' says Piercy. 'On the front it's about a 16in, the rears are 18in, but you get a lot more wheel travel than that. It's got around 30in of wheel travel.'

Also on the large size are the tyres, which are 32in tall. 'Most people [in Comp' Safari] run a smaller tyre, and that's been the done thing for as long as the sport has existed, but we've come from more extreme racing [in the US], where a taller tyre is pretty standard.'

Piercy helpfully tilts the Maverick so we can get a good look at the turbocharged, three-cylinder, 900cc Rotax engine and its cooling system. Rear wing looks the part but is for aesthetic effect only

Piercy's Can-Am Maverick has a very sturdy rollcage with a lightweight aluminium roof draped over it and very minimal bodywork. Its Fox shocks have been tuned by US damper guru, Wayne Israelsen

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Case study: Brian Birch's spaceframe Land Rover-Volvo

Birch grabs some air in his spaceframe Comp' Safari racer. Despite its looks, it's not really a Land Rover, but it does use axles pirated from the sturdy off-road classic

Competitive Safari is a very friendly environment and, while the competition is taken seriously, there is always room for a bit of fun. Which explains the Ifor Williams canopy on the rear of Welsh farmer, Brian Birch's, Class 7 machine, a spaceframe creation on Land Rover axles.

However, where you might usually expect to find a sheep dog, there is a 2.4-litre Volvo T5 turbo engine, which produces 300bhp in roadgoing trim. This has been 'tweaked a bit,' says Birch, though on buying the car he found it was down on power due to cooling issues. That's now been rectified thanks to the installation of a Davies Craig water pump, a Volvo S60 intercooler and a roof scoop that directs air into the engine bay. It also runs anti-lag, which Birch says is very useful, even though it does affect engine braking a little.

The powerplant was set askew by its previous owner / builder, something that was necessary to fit it in with the gearbox, an Elite sequential racing unit. 'It's a six speed, but we don't tend to use sixth, as I don't really like it over 90mph,' says Birch.

Birch has recently switched from a Quaife ATB differential in the front to a more open item as he was experiencing a little too much understeer with the former, although he says the jury is still out and he may switch back.

Either way, understeer is always an issue on broken ground, and this is where the fiddle brakes come into play, helping on turn-in by independently slowing a rear wheel. 'You've got a right fiddle [lever] that works the back right, a left that works the back left, and that helps significantly around the turns. I've also now got two sets of calipers on my rear brakes, because we found when we ran the fiddle brakes through the main braking system that, after using them, it affected my braking on the next press of the pedal.'

The car runs Fox dampers and weighs around 1250kg, with a good part of that weight in the Land Rover axles.

Birch says the car had been lowered a little too much by the time he bought it, so he has been slowly bringing the ride height up, using a rather clever engineering hack in the process: 'Every time we did a race, I picked the suspension up three quarters of an inch. And I would paint the bump stops each time. I would then go and do the event and see how shiny they were after. I've just kept doing that. It still bottoms out, but not as much as it did.'

Beneath the farmers' canopy – which was chosen for comic effect – is a Volvo T5 four-cylinder engine, positioned at a slant to make room for the Elite six-speed, sequential gearbox

'We've generally either got viscous coupled or locked centre diffs,' says Pink of the 4WD racers, 'and then some form of traction aid in the front and rear. My car's got the ATB [automatic torque biasing] diff' in the front, and then an LSD in the back. That's a fairly common arrangement.'

Grip is not just about differentials, though, the tyres also need to be up to the task. Surprising again then is that the choice of rubber is restricted, although this is for an interesting and sensible reason: 'We have had to introduce a tyre list,' explains Pink. 'Partly because we're trying to limit the ground damage. We've got a very good relationship with the landowners, and the more we can limit ground damage, the better it is for them. So, you can either use mud terrains, or some sites require us to use all terrains, and there is a list for both types of tyre.'

Punctures are quite common, particularly in the sidewalls, and it's interesting to note that, even with the importance of traction, most competitors don't run low tyre pressures, as they do in sporting trials, for example. 'Basically, on these faster tracks, the vehicle would squirm far too much,' says Pink. 'So it's usually 25-30psi, maybe even more.'

Incidentally, there's also the option to run with a passenger onboard, and many competitors do have someone riding shotgun. Their main job is to operate the windscreen wipers / washer, the horn when stuck behind traffic on narrow tracks, keep an eye on the gauges and remind the driver which way the course goes. A navigator of sorts, then.

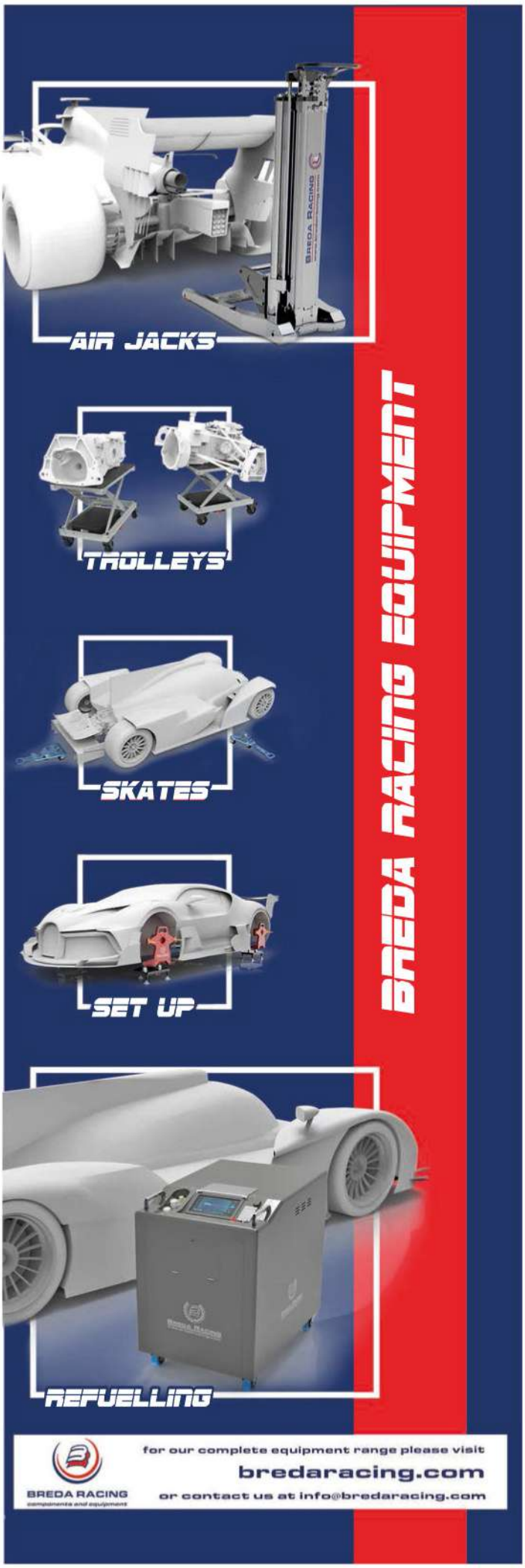
Mind games

While the odd car is fitted with a wing, there's little in the way of aerodynamic development in Competitive Safari, meaning those that are there are generally for aesthetic effect. A bit of subtle mind gaming perhaps?

Aero aside, it should be clear from the above that this is a discipline that's ideal for those who enjoy an engineering challenge, one that combines the need for speed with the necessity for building in a high level of strength and durability. Those involved in Competitive Safaris often take a very personal approach to this, and some of these diverse technical philosophies are outlined here.

While Brian Birch's car (above) might look like it's just driven out of a farmyard, it is a very specialised racing machine, as are many of the vehicles on the Competitive Safari scene. Despite some competitors spending a significant amount of money on building their cars, or on high-level components such as dampers, running costs are pleasingly low. Entry fees, for example, are just £150 (approx. $205) per event.

Perhaps the best thing about this unusual motorsport discipline, though, is that a newcomer can start with a roadgoing vehicle close to standard, fit a rollcage and then build it up as they progress through the classes. If you want to start a little further up the ladder, second-hand bespoke cars can be picked up for reasonable prices, and maintained on a sensible budget. In that respect, Competitive Safari offers a very pure motorsport engineering challenge that's within the reach of most. Just don't expect to spot a giraffe, or a banded mongoose out on course.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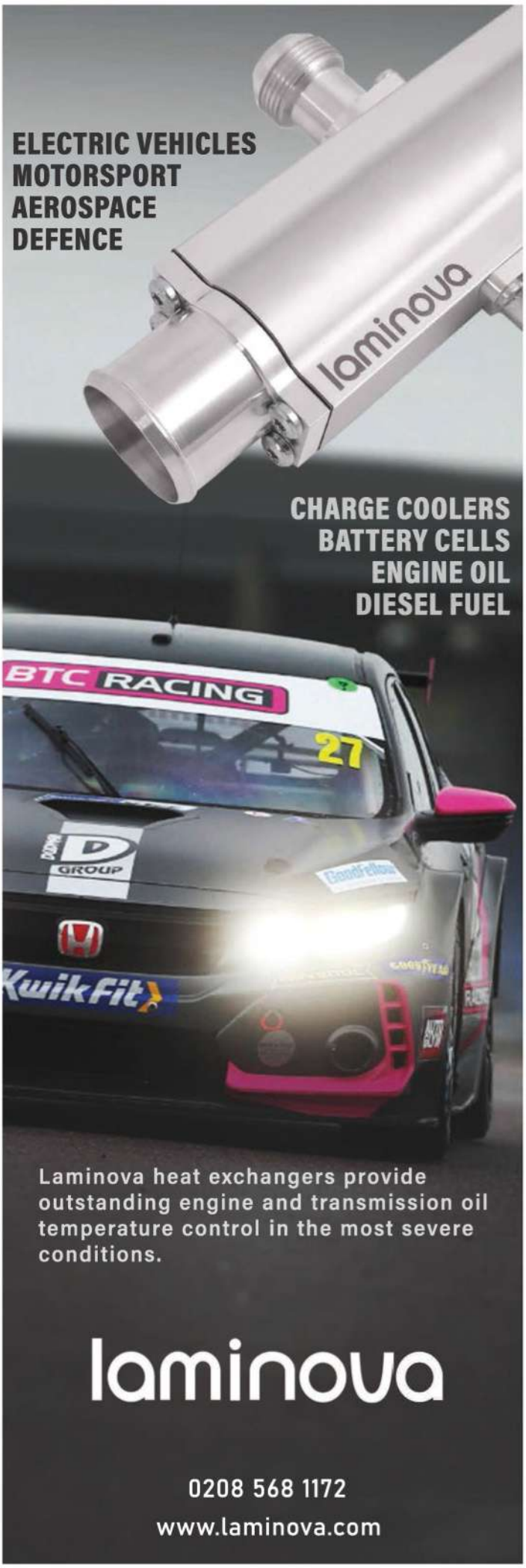
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Triumph of the 12

Enzo Ferrari tried a supercharged V12 to beat Alfa Romeo and came up short. Then a new man, Aurelio Lampredi, convinced him to ditch the compressor for a bigger engine

By KARL LUDVIGSEN

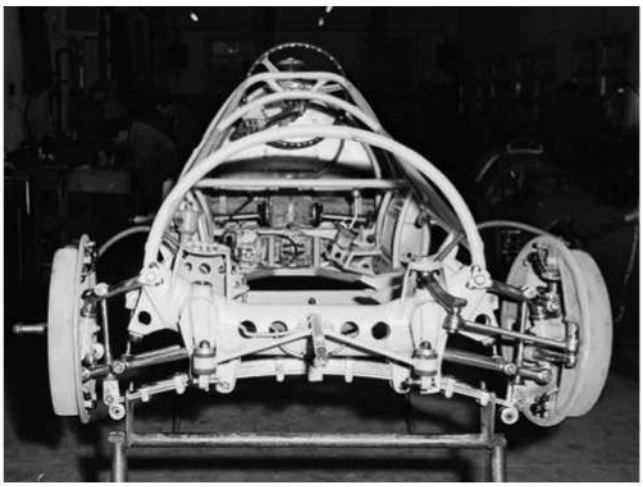
One of four Type 375 Ferraris delivered to Indianapolis for the 500-mile race of 1952. In the event, it didn't qualify, but it did go on to some great hillclimb appearances

Through 1949 and into 1950, Ferrari and Alfa Romeo were locking horns in the grand prix *corrida* with their highly boosted 1.5-litre racers. Swilling vast quantities of alcohol-based fuels to make power and keep cool, these supercharged machines had to make several pit stops to complete a 300-mile race. Meanwhile, the unblown 4.5-litre Talbot-Lagos were going through non-stop. Though their long-stroke sixes were far from state-of-the-art, France's Talbots showed that displacement could still make a race winner, if it was exploited with the latest technology.

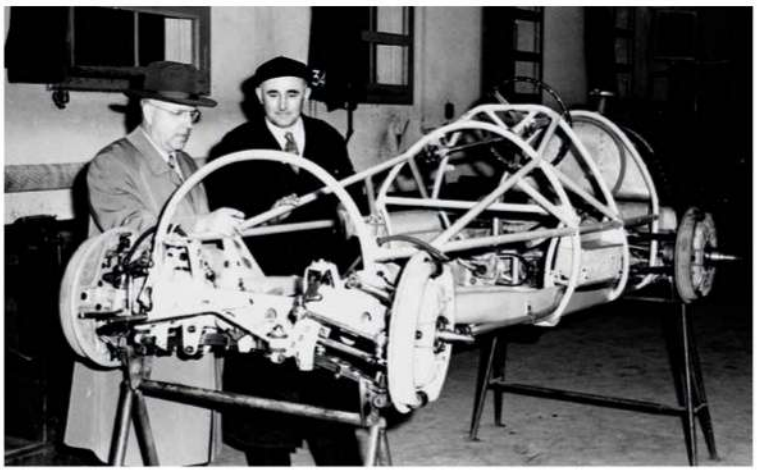
France's Talbots showed that displacement could still make a race winner, if it was exploited with the latest technology

A driver whom Enzo Ferrari esteemed, Parisian Raymond Sommer, had driven both the unsupercharged 4.5-litre Talbots, the early 1.5-litre supercharged grand prix Ferraris and, before the war, the Type 158 Alfas. His advice to Ferrari was that the better fuel economy of an unblown engine, with *adequate* power, would be a strong combination. Indeed, Louis Rosier proved this in the 1949 Belgian Grand Prix when his unblown 4.5-litre Talbot-Lago defeated the 1.5-litre supercharged Ferraris.

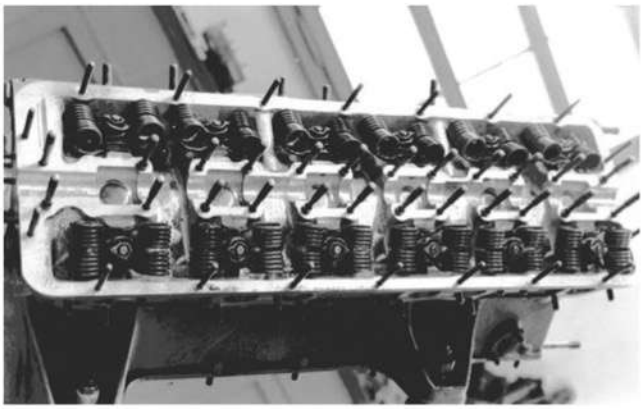
Fresh from his work with Reggiane-Caproni, producer of the W-18 aero engine, Aurelio Lampredi had arrived at Ferrari's factory at Maranello, near Modena, in September of 1946 and been assigned command of the drawing office. 'During my third month there,' he recalled, 'I handed in my notice because I realised my chief and I would never get on with each other. Ferrari



Brakes had two double cylinders apiece to apply shoes with central anchors. Transverse leaf spring flexed freely in the middle to give anti-roll effect



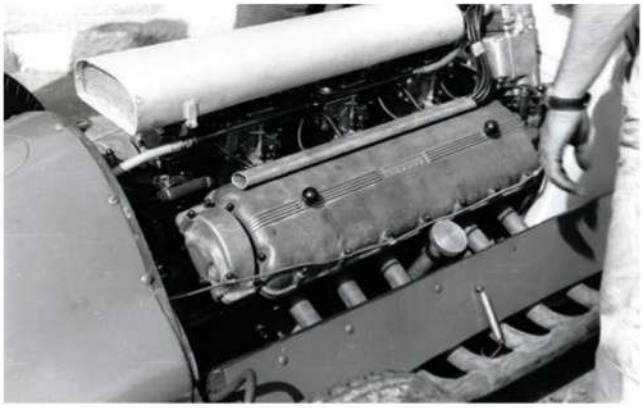
America's Gerry Grant (left) examines a 375 F1 chassis with Ferrari's senior mechanic, Luigi Bazzi. Grant went on to buy one of the four 1952 models that were sent to the USA



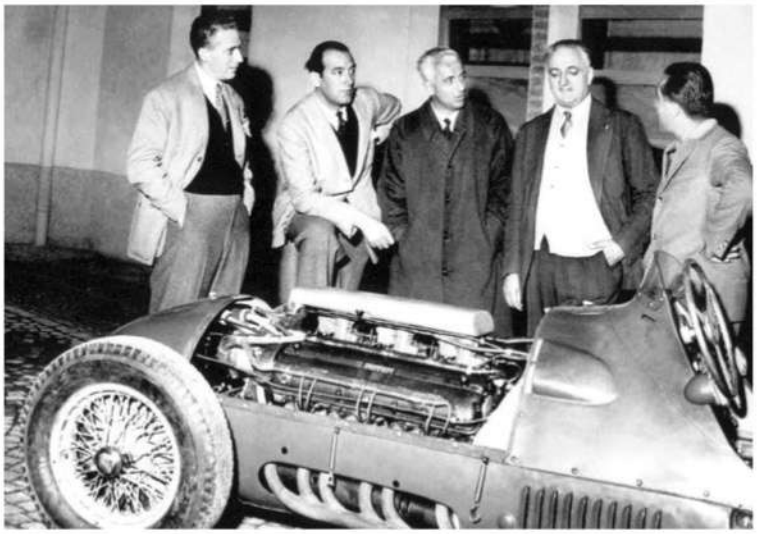
All valves were closed by double rat trap, or hairpin, springs. This was a characteristic of all Ferrari engines, including production cars, until the late 1950s

'Ferrari pointed out that I was young, and had no experience in racing car design. I would therefore be assisted by a consultant'

Aurelio Lampredi



Lampredi's 4.5-litre V12 was an impressive engine. It followed the general lines of the company's smaller V12, limited to 3.0-litres, but with many Lampredi improvements



Here with a 1952 dual-ignition Type 375 F1, (from left) team manager Nello Ugolini, designer Aurelio Lampredi, driver Luigi Villoresi, builder Enzo Ferrari and driver Alberto Ascari

would not accept my resignation and kept me there for three more months.

'After six months,' Lampredi continued, 'I resigned again…We came to an agreement on several conditions, one of which was that if I were to come back, I would be totally independent and have unlimited powers within the scope of my own work.'

Although not yet 30, Lampredi saw no reason to undervalue his experience. Born in Livorno, a port city near Pisa on the Ligurian Sea, he was the son of the head of a small engineering manufactory. After earning an engineering degree at the University of Fribourg in Switzerland, he apprenticed at Livorno's Odero-Terni-Orlando (OTO), which in the run up to war was making heavy artillery.

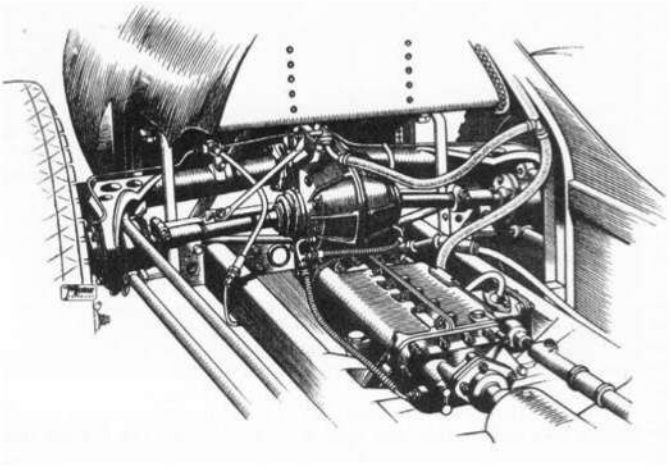
Radial and radical

'My first job was with Piaggio at Pontedera, working on radial aero engines,' recalled Lampredi. 'I then joined Reggiane-Caproni where we produced the 18-cylinder, inverted arrow engine with direct fuel injection and an automatic three-speed centrifugal supercharger. I was part of engineer Del Cupolo's team and I must say he was a brilliant man, both as an engine designer and as a mathematician.'

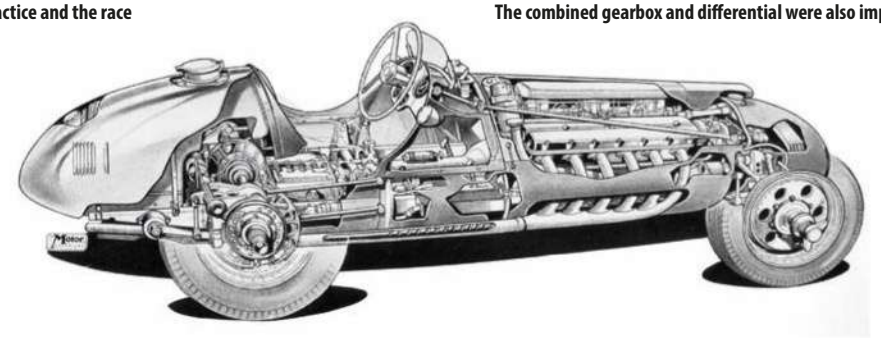
After his resignation from Ferrari, Lampredi moved to Milan where Luigi Fabio Rapi was directing the design of Isotta Fraschini's radical, and magnificent, post-war 8C Monterosa. The car's all-independent suspension, rear-mounted V8 and four-speed transmission became Lampredi's focus.

'After seven months, I received a 'phone call from Enzo Ferrari announcing that there had been a number of developments within the company and that the conditions I had set before leaving could now be complied with, [so] I went back to Maranello. 'However,' Lampredi added, 'Ferrari pointed out that I

The exposed aero windscreen and even exhaust spacing shows González was driving a 1950-model 375 F1 here at Silverstone. He dominated both practice and the race



New for 1950 was the modified de Dion rear suspension of the 375 F1. The combined gearbox and differential were also improved



In the new chassis for 1950, the de Dion tube's ends were guided by a pair of parallel radius rods, releasing the tube from torsional stress. The driver sat on the flat gearbox

Cowls were smoothed and a faired-in windscreen added by the Reims race in July.

These two shots of car no.14 show starter, González, and finisher, Ascari, in the same car

was young and had no experience in racing car design. I would therefore be assisted by a consultant. He mentioned the name of Gioacchino Colombo… Although I had never met him personally, I certainly knew him by reputation. I told Ferrari I couldn't have asked for anything better.'

Colombo arrived in January 1948 and remained, as a part-time consultant, for three years before returning to Alfa Romeo.

Rubber cheque

Before Ferrari could unleash Lampredi on a new, unsupercharged engine project, he had to find a way to finance it. Turning to tyre supplier and sponsor, Pirelli, he asked for a grant of some $20,000, further justifying the investment by saying the new 'big engine' would be suitable for sportscar racing and even production Ferraris.

Work on the new engine began in the summer of 1949. Although he kept the broad concept of Colombo's V12, with a 60-degree vee, single overhead cams on each bank and rocker arms, Lampredi made the engine his own. He fitted roller tips to his rocker arms to give them better durability and allow the cam

Although [Lampredi] kept the broad concept of [Gioacchino] Colombo's V12, with a 60-degree vee, single overhead cams on each bank and rocker arms, Lampredi made the engine his own

lobes to be narrow. Symmetrically disposed at a 60-degree included angle, instead of opposing each other directly, the valves were slightly offset longitudinally to allow their actuating rocker arms to be straighter than would otherwise have been the case. Spark plugs angled in from the sides of the head to cavities in the chamber. A single triple-roller chain drove both camshafts.

Lampredi expanded the cylinder centre distance from 90 to 108mm to provide room for bigger bores, which he fashioned as wet steel cylinders that screwed into the heads. The latter were deep, extending almost two inches below the combustion chambers to form the upper water jacket. The bottom ends of the cylinders were sealed to the crankcase by o-rings via grooves in their outer surfaces.

A Lampredi trademark was his doubling up of the crankcase flanks to add stiffness to an aluminium-alloy casting that was cut off at the crankshaft centreline and enclosed by a deeply finned sump. Racing versions had dry sumps, with a triple-gear scavenge pump, while road applications had wide wet sumps.

Growing pains

'I believe the best approach is to make small engines and then make them grow,' said Lampredi, proving it by baptising his new, unblown V12 as the 275 F1 at 3322cc (72 x 68mm) for the Belgian Grand Prix in 1950. This was an experimental outing, using a tuned version of the 275 S sportscar engine, but its success in powering Alberto Ascari to fifth place encouraged him to enlarge his 12 to 4102cc (80 x 68mm).

'A number of events occurred,' Aurelio related, 'which affected Enzo Ferrari's physical condition. He was ill and left Maranello for Viserba on the Adriatic.

On 14 July 1951, José Froilán González tackled the flat and fast Silverstone circuit in the UK with gusto, being the first car and driver ever to lap the track at more than 100mph

Ascari's first win in the 1951 season came at San Remo in the non-points contest. The varying exhaust pipe spacings tell us his 375 F1 has the dual ignition upgrade

Rivals, including González's friend and fellow Argentinian, Juan Manuel Fangio, were unable to keep the ebullient driver from beating the powerful Alfa Romeo Type 159s for the first time

González gained another podium with a third-place finish on the Nürburgring on 29 July 1951, this time finishing behind Ascari and Fangio's Alfa Romeo

'While the single-ignition 4100 was being installed on the test bench, I received a typical seaside resort postcard [with] the words 'the sun's tender touch' printed across the front. Ferrari's message written on the back was, "Hoping the 4100 will be a tender touch to Alfa Romeo."

Tender touch

'Some days later, we tested the engine,' added Lampredi, 'and our veteran technician, Luigi Bazzi, thought the test bench was out of order as the power recorded seemed too high. The test bench was stripped and reassembled twice until he was convinced the power reading was correct. All doubts dispelled, I drove to the Maranello post office and sent Ferrari a cable: 'Tender touch to Alfa Romeo is possible.' I also added the engine's power output. Three hours later, Ferrari was back at Modena, in perfect physical shape.'

The 4.1-litre V12 was putting out 335bhp at 7000rpm – more power than any other Ferrari yet built.

However, without chassis improvements, the new-found power would have been unusable. 'I had never seen a chassis before entering Ferrari and that, ultimately, proved to be my good fortune,' Lampredi explained. 'You really only needed to read up on the subject and acquire the necessary data to understand that the illustrious past of my predecessors could not solve the problems we were facing. Proving the car's stability and handling could be improved by adding 50kg of lead to the chassis side members was evidence of the fact my unbiased approach to the problem was a definite advantage.

The 4.1-litre V12 was giving 335bhp at 7000rpm – more power than any other Ferrari yet built

'I developed the de Dion axle with parallel trailing arms, so the axle itself would not act as a torsion anti-roll bar. I also produced the twin-piston brakes, with a centrally located fulcrum and leading and trailing floating shoes. And I introduced the four-speed rear gearbox, built in unit together with the limited-slip differential I had designed.'

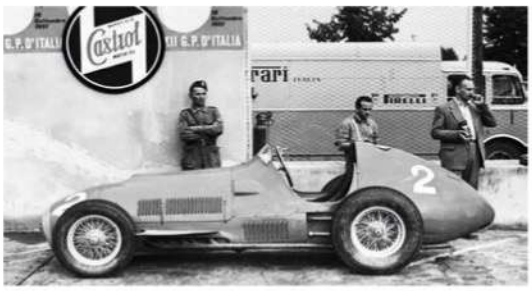
More than friends, Lampredi and Ascari were becoming partners in the race to the top, Ascari's inherent mechanical sympathy helping in the car's development.

This set the stage for the balance of the 1950 season, the first for the new, official Formula 1. It also mustered the return of the Alfa Romeos after a year of refraining from racing while none other than Goacchino Colombo oversaw improvements to the Alfa's powerful, but thirsty, two-stage supercharged straight eight.

Street racers

In those days, Geneva, Switzerland enjoyed its Grand Prix des Nations on the city's streets. The race on 30 July that year saw an excellent entry of current F1 cars, including Gigi Villoresi's 3.3-litre Ferrari 375 and Ascari's 4.1-litre version, both with uprated brakes, alongside four Type 158 Alfettas.

His new car restored Ascari to the front row of the grid, albeit two seconds slower than Juan Manuel Fangio's Alfa on pole. Villoresi equalled his time, so the two Ferraris were ahead of the other three Alfas at the start. In the race, Ascari kept his second place

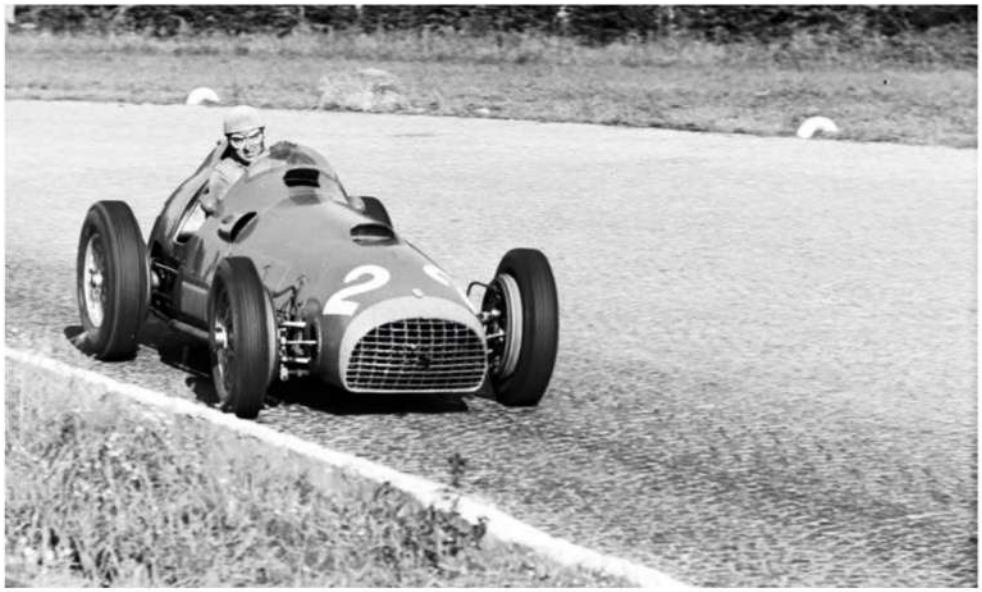


Seen before the Italian Grand Prix in September 1951, the 375 F1 shows its refinement of a raised rear deck for fuel and aerodynamics

Fifth on the grid at the Nürburgring in 1951 and fourth at the finish for 'Gigi' Villoresi, who ably stormed the track's famous Carousel. Piero Taruffi placed fifth in the race in another Ferrari

Omnipresent Pirelli Corsa tyres were prominent in Rudy Mailander's frontal portrait of a 375 F1 at Monza in 1951. Maranello swept positions one, two, four and five at the finish

All four works Ferraris at Pedralbes for the Spanish Grand Prix on 28 October had the new-style tanks and cockpits. Ascari was only two points in arrears from Fangio



Though third on the grid at Monza, Ascari put the Alfas out of their misery with a rousing victory ahead of González in second

behind Fangio through to six laps before the finish, when a valve dropped and destroyed a piston and cylinder. Nevertheless, he was still classified fourth.

Full speed ahead

With a longer stroke of 74.5mm, the 12 was opened out to the full allowable capacity of 4494cc for the last championship race of 1950 at Monza on 3 September. As the 375 F1, it was now rated at 350bhp at 7000rpm.

In speed, it was breathtakingly close to the Alfas. An unofficial Ascari practice lap was timed at 1m59s, the fastest anyone had gone at Monza. In official practice, Ascari reduced his time to 1m58.8s, only undercut by Fangio at the last moment by a scant fifth of a second.

Sharing the four-car front row with Alfa Romeos, Ascari set the pace. He hovered behind two Alfas, knowing his rivals in more thirsty cars would have to stop for fuel while he would not, only to have his axle give out 21 laps into the 80-lap race. At Dorino Serafini's pit stop for fresh tyres, his 375 F1 was commandeered by Ascari, as was his prerogative, to eventually place second, 18 seconds behind the winning Alfa after a hammer-and-tongs battle of attrition.

With a longer stroke of 74.5mm, the 12 was opened out to the full allowable capacity of 4494cc… [it] was now rated at 350bhp at 7000rpm

Alfa passed up the last Formula 1 grand prix of the year, the non-championship Penya Rhin GP, held on the Pedralbes street circuit in the suburbs of Barcelona. With its 194-mile distance, the unblown Ferraris had no need to stop for fuel or tyres and the winning trio of Ascari, Serafini and Piero Taruffi, all in 4.5-litre Type 375 F1s, made it a Ferrari party.

Dual ignition

In 1951, Colombo's now Tipo 159 Alfas won the new season's first three European grands prix, while the Ferraris were little changed, though under the skin they had dual ignition with a single large magneto at the front and additional spark plugs along the outside of each cylinder head. Cars with this modification displayed it with a non-equidistant exhaust pipe spacing. Body lines were also considerably smoothed.

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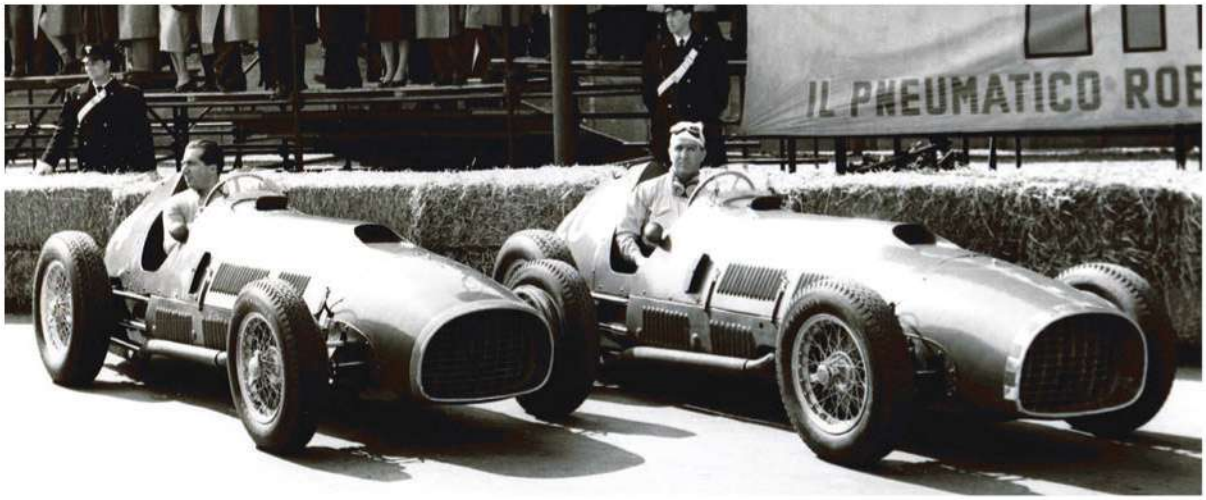
Ferrari looked to have every chance of delivering the new Formula 1 World Championship to Ascari in Spain, but poor tyre strategy threw the opportunity away

Here with Ascari in Turin, the 1952 car was aimed at Formula 1 rivals, but a lack of competitors led to the World Championship being for Formula 2 instead



Gearing up for the 1952 season, Ferrari made modifications to its 375 F1, including a groundbreaking, fully open cooler intake. Here Ascari and new pilot, 'Nino' Farina, pose

One place where F1 cars were still welcome was Indianapolis. In a semi-private project, Lampredi and Ascari schemed to compete, feeling they had a good chance at victory

Lampredi advanced his 375 F1. This improved version won at Boreham in the UK on 2 August 1952 with Villoresi, who set pole and fastest lap. Its new, three-eared knock-offs are a notable, post-Indy upgrade

The new model came good at Syracuse, Pau and San Remo, all races of which Alfa Romeo disdained. The first two went to Villoresi, with Ascari victorious at the third.

On 17 June, the F1 teams headed for Spa for the Belgian GP. Here, the Alfas showed an advantage in practice but, when their new, enlarged fuel tanks (up from 150 to 225l) were filled for the race, the Ferraris (carrying just 195l) were much closer. Villoresi retired early and Ascari made a stop on the 15th lap of 36 for fuel and rear tyres and then settled into second behind 'Nino' Farina's winning Alfa. The need to change tyres, forced by the high speeds reached, kept Ferrari from fully exploiting its fuel consumption advantage.

At Reims on 1 July, Ascari joined two Alfas on the front row of the grid and commanded an early lead, only to retire with mechanical issues. Then, when newcomer, Argentine José Froilán González, stopped for tyres and fuel mid-race, Ascari leapt into his seat and moved the Ferrari into the lead, only to then stop for brake adjustment, eventually crossing the line at a one-minute disadvantage to Fangio.

Historic day

At the 1951 British Grand Prix at Silverstone on 14 July, all runners were put in the shade by González, driving a 1950-specification 12-plug model, who recorded a 100.65mph lap in practice, the first time the British track's century had been surpassed. In the race itself, González dominated, defeating Fangio's Alfa by 51 seconds, with the best of the rest two laps behind. It was a historic day for Ferrari.

Ascari proved it was no fluke by winning the subsequent German and Italian Grands Prix, while only a miscalculation on tyre preparation by Ferrari gave the Spanish GP to Alfa and the World Championship to Fangio, with Ascari and González second and third.

A final moment in the sun came for Lampredi's 375 F1 at the 1952 Indianapolis 500. Ferrari sold three of the upgraded cars to Indy teams and entered a fourth for Ascari to drive. This was an 'unofficial' entry, motivated by Lampredi. He felt with their better fuel economy, the Ferraris had a potentially race-winning advantage.

The 'works' Ferrari was the only one of the four to qualify, helped by a batch of the latest four-throat Weber carburettors. Although Ascari and the red Ferrari earned respect at Indy that day, they retired with a right rear wheel hub failure at the 100-mile mark.

Lampredi didn't leave Indianapolis empty handed. Soon Ferraris were the first 'old world' racers to sport three-eared knock offs, and the upgrade soon spread to its rivals.

The Telegraph

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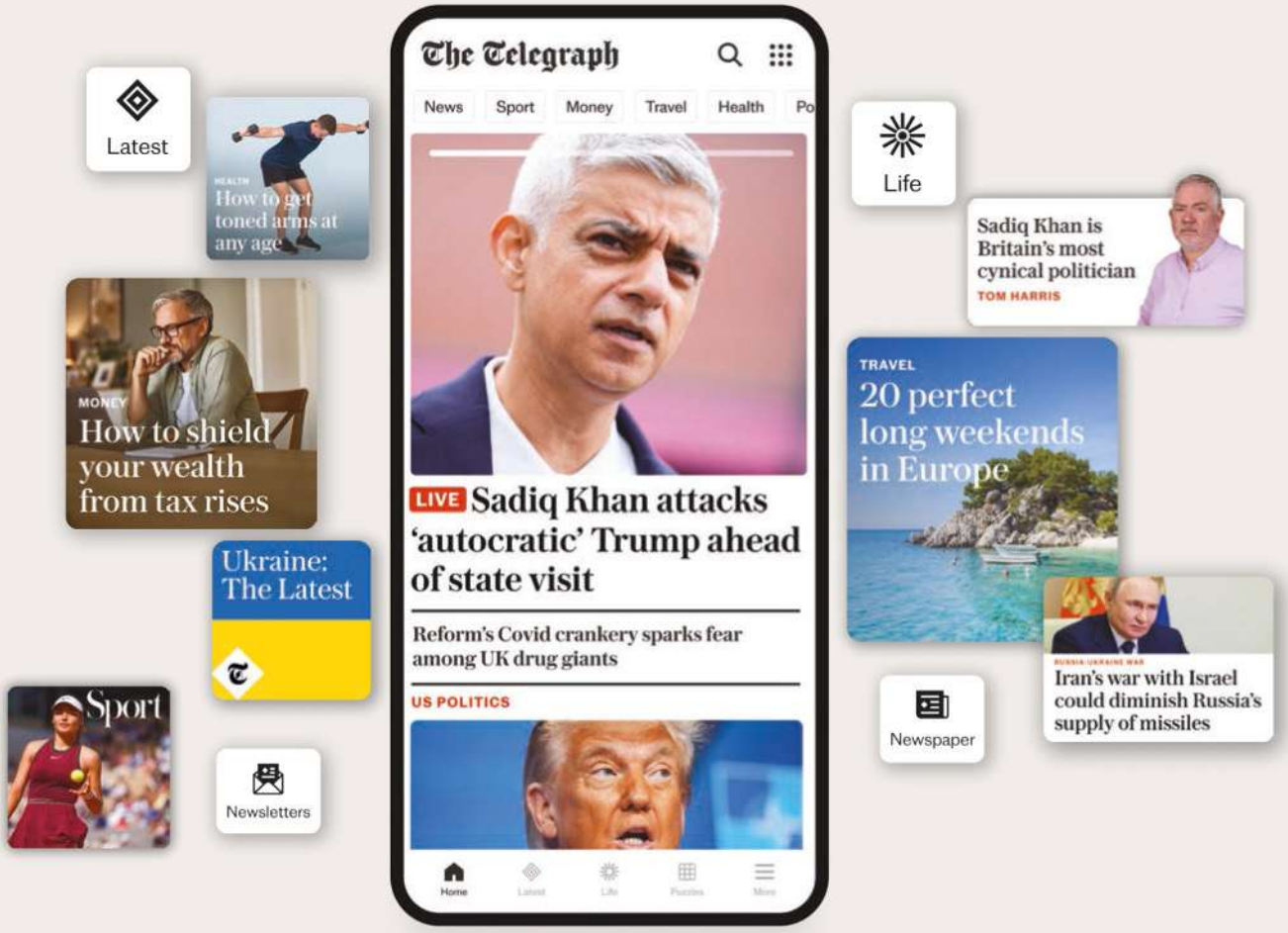

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IROC enjoys cult hero status for pitting top drivers against each other in bright and loud cars. Now the job is to cement its legacy

'It's not supposed to be about making a perfect car, and they probably weren't the best road racers. It was supposed to be about showcasing the best drivers'

Ray Evernham

Between an IROC and a hard place

The last IROC race was in 2006 but, with two reunions now under its belt, and the enthusiastic support of Ray Evernham, is the all-star saloon car series set to return?

By DON TAYLOR

Who is the best race driver today, regardless of series? An impossible question to answer you might think. But what if there was a series where the greatest drivers in the world all competed together in the same cars to see who really is the top dog?

The idea is not new. The Race of Champions has been doing exactly that since its creation in 1988, and other series have staged one-off events. Before the ROC, though, the International Race of Champions (IROC) created a multi-race series in the United States that ran annually for 30 seasons from 1973-2006 (with a brief intermission in 1981-1983). Organised by Roger Penske and partners, the idea was brought to reality with the quality for which Penske is known.

To someone outside the US, the IROC series may have appeared as stereotypically American fanfare, featuring American-built 'muscle' cars racing around high-banked, paved oval tracks, dominated by NASCAR and open-wheel drivers with experience of such circuits. But look closer. International sportscar and Formula 1 drivers were always in the invited mix, and European greats such as Graham Hill, Jackie Stewart, Martin Brundle, James Hunt, Derek Bell, Jackie Ickx, Niki Lauda and Dario Franchitti have all competed. Along with several American drivers who became known internationally when they crossed over from NASCAR, open wheel and sportscars into F1, including Mario Andretti, Dan Gurney and George Follmer.

Admittingly, the IROC may have been stacked against the 'foreigners' with the style of cars, and the type of tracks, especially when the road courses that featured in the early days were left behind for an oval track-only format in the series' later years.

No matter what its level of international visibility and participation, the IROC, with its Easter egg-coloured cars, proved a very popular series with US motorsport fans over several decades, and consequently was able to attract car manufacturers, sponsors and a strong TV package throughout its life.

Now, over 50 years since the first IROC race, and 20 years since the last, nostalgia has kicked in, and it's time to look back at what was a hugely successful race series.

The Evernham effect

We are not the only one giving IROC another look. Ray Evernham, who has a special interest in the series, has been at it as well. Evernham is best known as the man who led the team behind several of Jeff Gordon's NASCAR Cup championships. Since then, he has become a NASCAR team owner, TV personality, NASCAR Hall of Fame inductee and serial car collector.

Before his successful run with Gordon, though, he worked for IROC from 1983-1989, building and prepping the cars, doing some of the test driving, and working to make the wide variety of drivers happy with the performance and 'equalness' of the racecars that ran in the series.

Evernham is quick to acknowledge the Penske-owned, Jay Signore-run operation changed his life, noting in his 2024 book, *Trophies and Scars*, 'IROC taught me discipline and gave me the skills to run a winning team.'

Indeed, Evernham has been so appreciative of, and in love with, IROC that he set upon collecting some of the original racecars. Not stopping there, last year he and partner, Rob Kauffman, purchased the rights to the dormant series. Along with that came a treasure trove of documentation on all the cars that once raced. That led to the pair pulling together as many of the seven generations of IROC cars they could locate for an IROC reunion, first held at Lime Rock Park last autumn, and again in August 2025 during the Monterey Motorsports Reunion at Laguna Seca. An incredible 26 of the original cars came together for the California event, along with many of their original drivers.

One ritual at the reunion is a group photo of the assembled cars, which led Evernham to comment, 'That's the first time I got a little bit emotional, when we had all generations of IROC in one place for the first time ever.

First and last generation IROC cars together, a Porsche 911 RSR of 1973 and Pontiac Firebird Trans Am of 2006

Kurt Busch, Jenson Button and Ray Evernham discuss the IROC cars post-race at the Laguna Seca reunion

'If you cats are gonna run on high-speed ovals like Daytona and Michigan, you'd better get a real racecar'

Richard Petty, seven-time NASCAR Cup Series champion

Notable drivers participating included former competitors, Al Unser jr (1988 IROC champion), Mark Martin (five-time IROC champion), Bobby Labonte (2001 champion), Kurt Busch (2003 champion), Dario Franchitti, Jeff Gordon, Danny Sullivan, Bill Elliott, Ken Schrader and Scott Pruett. Also behind the wheel were 2009 F1 champion, Jenson Button and McLaren Racing CEO, Zak Brown, while the event's winner, Tomy Drissi, is a former Trans Am champion.

For three days, the drivers enjoyed some friendly jousting on track, followed by much laughter and storytelling later. Making the memories even better, some of the cars were tended to by their former mechanics, people like Rich Laubenstein, who worked with Evernham in the 1980s.

K.I.S.S.

Sitting down with Evernham back at his workshop in Mooresville, North Carolina, I was able to dig deeper into some of the mechanical aspects of the cars themselves, and hear his plans for the IROC brand.

Gen 2 IROC cars were 1975 / '76 Chevrolet Camaros. This example was once driven by James Hunt

Key to the success of the series was keeping the cars simple. While perhaps not very innovative, they were products of a well-disciplined build, development and preparation process, as well as repair procedure, to ensure equal performance. In total, there were seven generations of IROC racer, but the differences can be readily simplified as we peel down to the core of their technology.

The series began in 1973 using identical, 3.0-litre Porsche 911 RSRs. That format only lasted two years, though, as it very quickly became expensive, and the rear-engined European sportscars didn't suit the experience and driving style of the numerous NASCAR and open wheel-driving champions the American audience expected to see racing. The IROC series also ran entirely on road courses in its first year; banked ovals were only added in year two.

Putting aside the story of the IROC Porsche 911s for another day, we'll focus here on the remaining six generations, which were all of similar mechanical configuration underneath, skinned with American muscle car bodies of one brand or another.

American muscle

Post-Porsche came the IROC Generation 2 cars, the 1975-'76 Chevrolet Camaros. The Penske racing group started with stock, steel-bodied production Camaros, in the same way as the early SCCA Trans Am series did. Comprehensive rollcages were added, along with some heavy-duty, factory-homologated parts for braking and cooling. The single carburetted, 350ci (5.7-litre) V8s were reworked to produce about 500bhp, and off to the track they went.

About that time, according to Evernham, seven-time NASCAR champion, Richard Petty, said, 'If you cats are gonna run on high-speed ovals like Daytona and Michigan, you'd better get a real racecar.' To 'The King', that meant a NASCAR kind of racecar.

And so was born IROC Generation 3, this time based on 1977-'80 Camaros. The contract for the 110in (2794mm) wheelbase chassis went to Edwin 'Banjo' Matthews, a prominent stock car builder of the era. The North Carolinian former driver had been known as Banjo since his school days because

of his round, gold-framed glasses, which to some resembled the body of the stringed instrument, in case you are wondering.

From that point forward, the IROC car formula became a steel tube chassis, dressed in glass fibre / composite body panels. The front-mounted, production-based pushrod V8 of about 500bhp remained.

That brief explanation now makes it easier to describe the next four generations of car: Generation 4 was similar, but saw a shorter, NASCAR-type chassis introduced under the new 1984-'89 Camaro body. Generation 5 saw that car re-bodied as a 1990-'93 Dodge Avenger, and then again as the 1994-'95 Dodge Charger for Generation 6. A slightly different chassis was introduced for the 1996-'06 Pontiac Firebird Trans Am-bodied cars that define the final, Generation 7 racers.

NASCAR chassis

As the Generation 4 platform ran for a dozen of the series' 32 years, albeit under three different corporate identities, that's the one we'll focus on here. It also happens to be the one Evernham is most familiar with.

With only four races per year on the IROC schedule in its heyday, provided they hadn't been crashed, many of the cars that competed were low mileage cream puffs when they were put out to pasture.

When Chevrolet introduced its all-new production Camaro for 1984, it was a wildly different car, with a more steeply angled windscreen and different proportions. New cars were needed for the series to reflect this. Again, Banjo Matthews was picked to build the bare chassis, this time with a 105in (2667mm) wheelbase, and they were sent north to Jay Signore's shop in New Jersey for assembly and fielding. Signore, a trusted lieutenant of Penske, was now put in charge of running the IROC operation.

That's when the young Evernham, a Northeast Modified (hybrid between a stock car and open-wheel racer, run on short ovals) driver, found steady employment, and consequently honed his skills for future success: 'Jay Signore is an amazing mentor,' he recalls. 'So many of us that came out of the Jay Signore School of Racing went on to be crew chiefs in NASCAR, open wheel and in sportscar racing. He is responsible for a pretty big footprint in auto racing, winning so many major racing championships with the things he taught us. You look around the inside of these cars, and you can just see how sanitary these things always were.'

When the new Banjo chassis arrived at Signore's shop, it was a bare steel structure, with only a windscreen bed, a steel roof and a few interior shield panels in place. At its base was a stamped steel, production Ford Fairlane floorpan, typical of NASCAR Grand National car construction practice at the time.

Once the 911s had been dropped, from Gen 2 onwards all IROC racers used a front-mounted, pushrod V8 engine

'So many of us that came out of the Jay Signore School of Racing went on to be crew chiefs in NASCAR, in open wheel and sportscar racing. He is responsible for a pretty big footprint in auto racing'

Ray Evernham, principal at IROC

US manufacturers used IROC to promote new models, and for Gen 4 it was the '82-'92 third generation Camaro's turn

Chassis for Gen 3 through to Gen 6 cars were built by Banjo Matthews. Gen 4 shown. Note the well protected fuel cell

Driver impressions

Bobby Labonte

Several times an IROC race was held on the same weekend as a NASCAR Cup race, and Bobby recalls jumping from one car to the other: 'We were pretty aggressive earlier than most people, as far as softer front springs, and a bigger sway bar, along with a rear sway bar [on the Cup car]. We had a package that definitely had a different feel to it. So, when you jump into the IROC car, you know it had a different aerodynamic package and they're all equal. It probably had a pretty big right-front spring in it, a pretty standard rear spring set-up, and probably a little more split in the back, because it didn't turn as good, plus it had a little bit slower steering box. To me, it was not as nimble as my Cup car, and it had a slower-like motion.

'We didn't have to worry like in a Cup series points race where we're going to jeopardise our full season if you tear your car up. With the composite body front end [on the IROC car] you can push and shove, and draft tight.

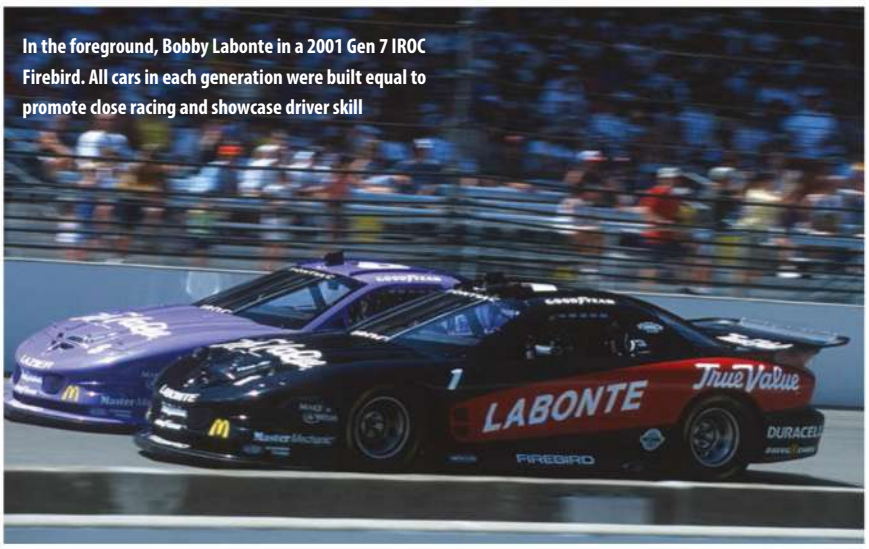
'I thought for the most part they were pretty close, but I knew that if my car was too tight on the first lap it was going to be too tight at the end of the race. If I was a bit free to start with, like at the Brickyard, I can make this last for 40 laps, and win.'

And win Labonte did, at the Indianapolis race in 2001, where he also captured the IROC season title ahead of Tony Stewart and Kenny Bräck.

Ken Schrader:

USAC open-wheel champion, Ken, had a shorter, but similar response when comparing the IROC cars to the many racecars he had driven: 'Less power, slower, more forgiving… but a lot of fun.'

Gen 4 IROC 'rear steer' front suspension system



In the foreground, Bobby Labonte in a 2001 Gen 7 IROC Firebird. All cars in each generation were built equal to promote close racing and showcase driver skill

Nigel Kinrade

'We then put all the brackets on, the seat mounts, window net mounts, dash, all of that stuff,' adds Evernham modestly. Not mentioning the rather more important steering, suspension, brakes, drivetrain, electronics, coolers and water and oil lines, before finally adding the body panels, installing the window glass and painting everything that needed it along the way.

The chassis structure consists of a centre section, plus separate, welded-on front and rear clips. The centre section contains the entire heavy duty rollcage, complete with four anti-intrusion door bars on the driver and passenger sides, requiring the driver to climb in and out through the side window.

Evolutionary design

The front and rear structures were evolutionary designs comprising a combination of rectangular and round tubing and flat plate. Reducing vehicle weight was barely given a thought, robust reliability and safety were the priorities. A minimal weight of 3300lb (1497kg) for NASCAR Cup cars of the era did not encourage 'adding lightness'.

Note also that CAD for vehicle design was not widely available at the time, and the PC had only recently been introduced (the first Apple Macintosh home computer came out in 1984). Even a simple twist test to measure torsional rigidity was rarely done. Chassis builders would learn from failed joints and beefing things up as a result.

Both front and rear clips were designed to be sacrificial in an accident, hopefully absorbing enough energy in the process to bend without damaging the centre section.

Reducing vehicle weight was barely given a thought, robust reliability and safety were the priorities

When the inevitable did happen, they were simply sawn off and replaced with a new clip (finally, on today's NASCAR Cup cars, the clips are more handily bolted on and off!).

Suspension tuning

Front suspension was by way of traditional double A arms, with a large, squat coil spring, a separately mounted double-action shock absorber and a large diameter anti-roll bar. The upper arm was welded tubing, the lower a stamped production part with forward-facing strut. Both attached to a modified production spindle (stub axle).

Steering was of the production, hydraulic-powered, recirculating ball type, and acted on the front wheels. Slightly confusingly, the Banjo chassis were known as 'rear-steer' cars. Translation: the steering box and tie rods were located to the rear of the front axle centreline, uncomfortably below the engine's oil pan and exhaust headers.

Tuning the front suspension is how one would expect, by simple camber and caster settings, often different left to right to compensate for the banked ovals. And, of course, with interchangeable springs, shock absorbers and anti-roll bars.

The rear suspension consisted of a solid axle, located by trailing arms (known as 'truck arms' as they originally came from a classic American pick-up truck), and a Panhard or track rod for lateral location. More coil springs and shocks held it all up. No rear anti-roll bar was used in the early days. Beside spring and shock selection, tuning at the rear end was possible by adjusting track bar height to change the roll centre, and altering 'wedge' with screw jacks at the spring mounts.

Disc brakes were employed on all series of IROC cars. Their source at the beginning was production GM units, through Hurst Airheart, improving eventually to Brembo calipers and steel discs on the Generation 7 Firebirds. Carbon discs were also reportedly considered at one point but never introduced.

Examining the different generations of IROC cars, one can see the industry's evolution of seat safety and driver environment

The final, Generation 7 IROC racer was slightly more refined, with a new chassis built by Mike Laughlin in North Carolina

In the latter stages of IROC, the V8 engines were built in-house. Note the Pontiac valve covers on this Firebird

A small but significant difference with the Gen 7 car was the change to a 'front steer' front suspension system

For wheels, durable, 15in (381mm), five-bolt steels were standard from Generation 3 to 7.

After the short-lived flat-six era, several different engine builders were engaged to build the pushrod V8 power units. The early Camaros relied on engines from a trusted Trans Am series engine supplier in California, TRA-CO. Later, Katech Engines was employed, while later still engines were built in-house by IROC. The major small block V8 parts used came either from GM Performance or Chrysler / MoPar.

With a goal of adequate power, and great reliability, engines were tuned to around 500bhp max. Keeping it simple also meant using a single, four-barrel carburettor (NASCAR Cup cars only reluctantly switched to EFI in 2012, so why would IROC have considered it, even as late as 2006?).

In all IROC cars after the Porsches, a four-speed, full synchromesh, manual transmission was used, with long-throw, H-pattern shifting. No paddles, no sequential selection, no automatic rev matching, just regular old Borg Warner T-10, or aftermarket Jerico units, were most frequently used.

Driver safety

What they may have lacked in mechanical refinement, the IROC cars made up for in safety, generally keeping pace with the development of driver protection applied in their NASCAR counterparts.

Examining the different generations of IROC cars, one can see the industry's evolution of seat safety and driver environment. The early cars have the single layer, aluminium shell seat with minimal padding, fed by randomly mounted shoulder straps and seatbelts. The last cars, the 1996-'06 Firebirds, had the structurally sound, wrap around the shoulders, surround the head, foamed-in-place seats we recognise today, with the drivers held firmly in place by a minimum six-point belt system, fitted with the correct mounting geometry. Since their initial build, some older surviving cars have been upgraded, but not all.

Whatever the seat currently in the cars they were piloting, all the IROC drivers I saw at Laguna Seca were using a HANS, or similar, device. While putting on his own at the track, 1985 Indianapolis 500 winner, Danny Sullivan, reflected, 'The real sad thing is the HANS came about only late in my driving career.'

One major difference between NASCAR and IROC car build practices was in the way the bodies were crafted. NASCAR 'stock' cars had steel bodies, largely hand formed on wheeling tools. IROC car bodies, at least from Generation 3 onwards, were mostly glass fibre and / or a glass fibre composite. To keep the manufacturer, and fans, happy, body surfaces appeared stock looking at first glance, but had been artfully modelled in clay first, pulled and stretched to fit tight over the chassis and tyres, while at the same time maintaining the manufacturer's product identity. Detroit car designer, Randy Wittine, gets the credit here as IROC's long-time creative director.

Aerodynamics

Look closely and you'll see the front fascia / bumper areas are the most notably re-worked parts to create front downforce and increase stability. The rear of the cars all feature a prominent spoiler, which steadily evolved from a large blade added to the production rear lip on the early Camaros to a large tray with a kick-up. The parts were often made in clear polycarbonate to minimise them visually, and a selection of variable height add-ons and side panels allowed mechanics to tune the cars' aero behaviour.

Evernham explains: 'You can see all of the little aerodynamic details on the cars that were bolt on and bolt off because they raced at several different places, like Michigan and Talladega, and also ran on road courses.'

He also recalls, with a smile, '[The drivers] were always trying to talk you into putting a little round of wedge in, or letting a little air pressure out of the tyres, or messing with the spoiler… all in good fun, but serious in trying to find any edge.'

Later generation cars also included the wind tunnel-developed, flip-up, anti-lift roof panels and rails used in NASCAR to break up airflow and keep the car from lifting off track if the yaw angle exceeded 80-90 degrees.

Final iteration

So, just how different was the final, Generation 7 IROC car? As already noted, its silhouette body resembled that of the 1996-2006 Pontiac Firebird Trans Am, but this was the first version since the Banjo-built, NASCAR-style tube frame was introduced for the Generation 3 car that moved away from that established formula.

As the Dodge Avenger IROC programme wound down in 1995, those cars were sold off, only for GM's Pontiac Division to unexpectedly express interest in joining IROC

for the 1996 season to help promote its new Trans Am model. That required new cars to be built in short order, and with that came a change in chassis supplier.

With Matthews out of the chassis-building business (he died in October 1996), IROC had to look elsewhere. Mike Laughlin in South Carolina was supplying many NASCAR teams with a chassis design that was racking up a ton of wins. Overall, it was very similar to the Banjo design (as all NASCARs of the time were), but Laughlin had incorporated something different. Instead of the rear steer feature, he had switched to – wait for it – front steer. Yes, the steering box and tie rods were moved to the front of the front axle line, and what a difference it made. Whether from compliance steer, bump steer or an unexplained, stumbled-upon geometry quirk, it worked. And it worked well.

The Gen 7 Firebird also had other notable detail improvements. The front bodywork now featured a true splitter at the bottom, as well as a battery and oil tank moved around for better weight balance. Ducts were added in the b-pillars for rear brake cooling, and a Jerico four-speed transmission and Dana quick-change rear end were fitted, along with Brembo brakes. It was even tuned for radial tyres, and the sleek body design gave it the slickest look of them all.

Driver feel

Making the cars raceable, and equal, was top priority for Signore's crew. While the cars' every physical dimension was measured and compared in the shop, the real proof came out in track testing. Remember this was before the common use of electronic, sensor-fed data acquisition. The Pi Research first-generation data recorder didn't come along until 1988; too late for IROC Generations 1 through 6. The evenness of the cars' performance was therefore measured by the stopwatch and driver feel.

Test drivers called in for the new Generation 7 car included George Follmer, Dave Marcis, Jim Sauter and Ray Evernham himself, who recalls, 'They were all the same. It's not supposed to be about making a perfect car, and they probably weren't the best road racers. It was supposed to be about showcasing the best drivers.'

That's precisely what IROC set out to do from the beginning and, while not everyone got a crack of the whip, it's what it will best be remembered for.

Scan the QR code to view the in-progress IROC car registry

What's next for IROC?

Among the information and data Ray Evernham has collated are the original IROC car testing notes

With the purchase of the IROC brand and marketing rights, Ray Evernham now has boxes of notebooks, files and photos. Fortunately, under Jay Signore's guidance, the IROC organisation documented each car's build and development. With the assistance of TV race announcer and racing historian, Matt Yocum, Evernham is now going through the paperwork: 'What's really cool is that some of them have three or four logbooks, because they've been through so much history. Many started as a Camaro, and then became a Daytona, and then an Avenger.'

On top of this, he has been receiving and collating IROC items sent to him by former mechanics, drivers and fans.

IROC Registry

The next stage is to create a registry, which will include a heritage of each car, detailing every driver who sat in it, each race it competed in and every mechanical change.

'It's a legitimate IROC registry,' says Evernham. 'Using it, we can help people really identify their cars, find out which ones they were, because there's a lot of cars out there that are not really what they're being represented as. That's not intentional, maybe somebody's gotten the wrong information, so we spent a lot of time with Jay Signore, and we've been collecting pictures and history. We have access to all the IROC records from day one'

Reunion events

Evernham says he would also like to organise more reunion events like those at Lime Rock and Laguna Seca: 'Our goal is no more than four events a year, but it's probably going to be three – one on the east coast, one somewhere in the central states, and one on the west coast. It depends on how many cars we can get to come out of the woodwork.'

From research done so far, he estimates 75-80 original IROC racers still exist.

These events would feature some of the same drivers who competed in the original IROC series, alongside some of today's top drivers, and even the sportsman owner / drivers of some of the cars. 'They were meant to be raced, and raced hard. If they get banged up, we know how to fix them back to the original specs.

'The IROC cars really represent an opportunity to own a reasonably-priced vintage racecar, one that's low cost to maintain, with an unmatched history with the number of legendary drivers who wheeled them. And with our records and registry to authenticate their provenance, they can only go up in value.

'If you're really a fan of motor racing, come and look at the IROC cars. The list of drivers that have driven some of them is incredible. You've got cars that have been driven by 25, 30 of the most incredible drivers in the world. We have cars that have been driven by James Hunt, Jody Scheckter, Brian Redman, David Pearson, Richard Petty, Dale Earnhardt… So many talented people have sat in those seats and worked those pedals and that steering wheel.'

'So many talented people have sat in those seats and worked those pedals and that steering wheel'

IROC return?

So, is there any chance of developing a future IROC series? Could we see the likes of Oscar Piastri and Max Verstappen go head-to-head against Alex Palou, Joey Logano and Shane van Gisbergen?

'I think the sport has evolved,' says Evernham, 'and I really believe there is a space for another form of motorsport entertainment. There's a younger group of people coming up now that maybe aren't as interested in all the rules and infractions… and if we were able to take that interest and focus on the personalities and really tell the story of these guys and girls. Then put them in equally prepared cars, with no penalties, purely driver against driver. It then becomes about talent, and then you tell the story of those personalities. That could draw people in, so they start to understand what Max Verstappen does, what Kyle Larson does.

'Unfortunately, over time, IROC kind of progressed to an era where the stock car guys had an advantage, and that was a mistake. Our design for a new car would be one that is very neutral, so Formula 1 drivers couldn't have an advantage. Nor could sportscar, stock car or open wheel drivers. Our car wouldn't be like anything else on the planet, it'd be a combination of all those things, with the focus on the superstars, on tracks and with equipment that doesn't favour anybody.'

That all sounds very exciting, but for now, Evernham's focus is on the existing cars, the 20-50-year-old historic time capsules with stories to tell. IROC stories. And he wants more people to re-live the excitement of those times, hear the cars rumble and take to the track again, with great drivers once more behind the wheel.

Parity politics

The technical approach taken to equalising the field in Australian Supercars

By GEMMA HATTON

Australian Supercars maintains an extremely close and competitive grid, having had intensive technical parity between manufacturers for over 30 years now

'We equalise based on a tightly controlled, homologated vehicle design. This ensures that any driver or team running any of the available car models has equal opportunity to win'

Perry Kapper, Supercars category technical manager

Heading into the Bathurst 1000 in October, the 2025 Supercars Championship season has delivered eight race winners across six teams, with three different drivers taking turns leading the standings.

The 24-car strong field has been separated by just one or two seconds in qualifying, with each race a frenzy of nose-to-tail-battles and overtakes. This impressive on-track competitiveness is no fluke, but a result of a comprehensive technical parity process that is unique to Australian Supercars.

'We are a technical parity series, which means we don't equalise based on the performance of a driver or team,' explains Perry Kapper, Supercars category technical manager. 'Instead, we equalise based on a tightly controlled, homologated vehicle design. This ensures that any driver or team running any of the available car models has equal opportunity to win, with no inherent advantage of using one manufacturer over another. In that respect, we differ from pretty much every other racing series in the world.'

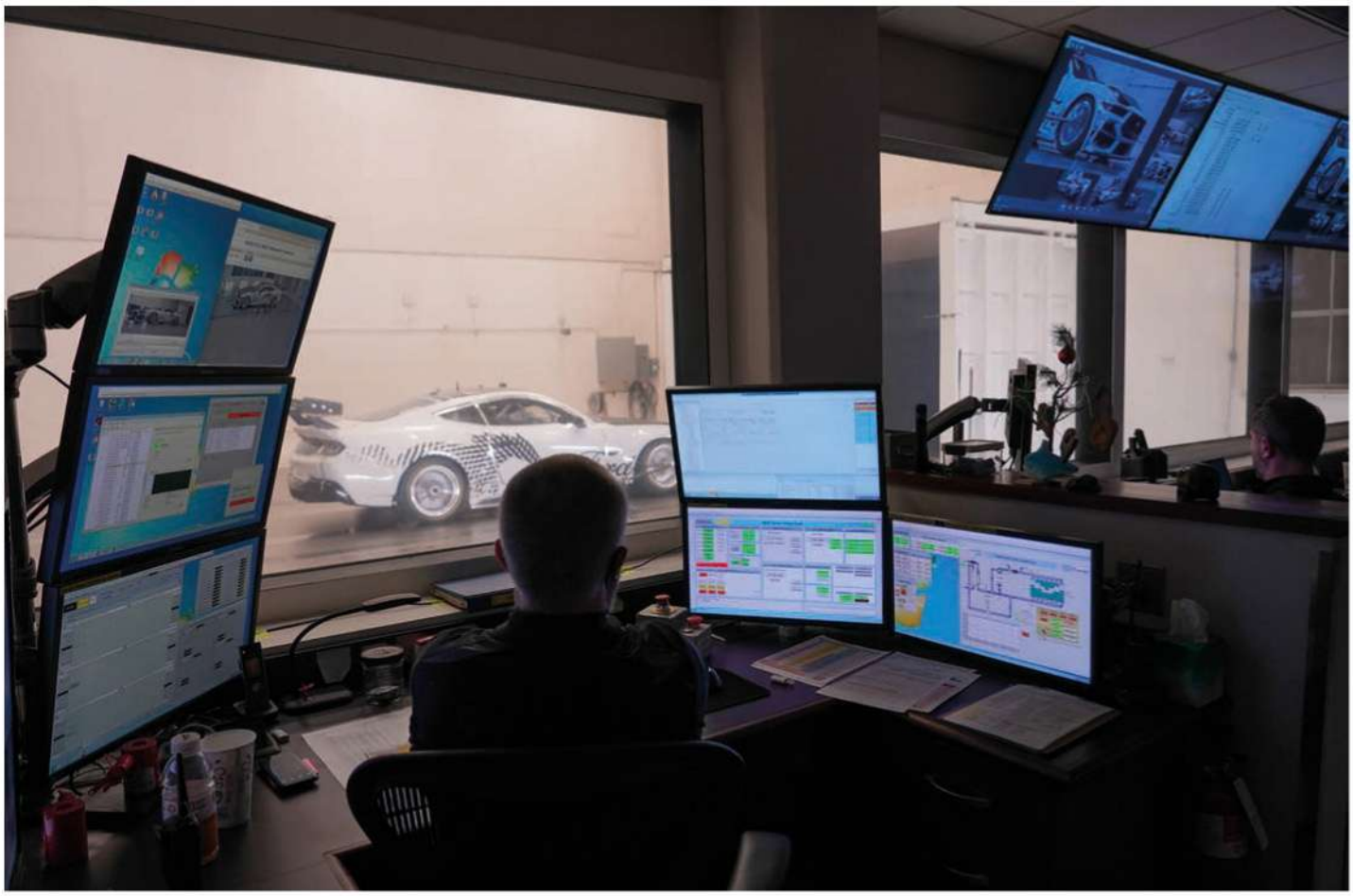
Pillars of parity

This technical parity process is defined by several 'parity pillars', which include engine power, aerodynamic performance, fuel economy and vehicle c of g. Within each of these are several requirements, each with defined windows a manufacturer must meet.

Take the engine as an example. Every power unit is tested on a water brake dynamometer at the Supercars Engine facility in Queensland, and its power curve must be within a certain tolerance of that which is defined by Supercars. If any point in the rpm range is too low or too high, the engine is sent back to the manufacturer to be adjusted before it can be raced by the teams.

'We are continuously developing and expanding our parity process, adding new elements all the time,' says Kapper. 'We've recently started testing engines on transient dynos at facilities like AVL in Detroit. This allows us to characterise engines more closely, so we can target down on areas like transient performance, engine inertia, acceleration, driveability and throttle mapping.'

Now let's consider aerodynamics. Previously, all aerodynamic homologation testing was completed on runways but, at the



To ensure aerodynamic parity, all wind tunnel tests take place at Windshear in North Carolina (shown here is a 2023 car ahead of the 2024 season). The results are then correlated with CFD

end of the 2023 season, Supercars adopted a combined wind tunnel and CFD testing approach. The category's engineers, along with its CFD partner and homologation teams, developed several target aeromaps. These define total downforce, total drag, lift-over-drag ratio and aerodynamic balance for a sweep of ride heights, yaw angles and roll angles. One car from each manufacturer is then parameterised against this aeromap at Windshear's rolling road wind tunnel in North Carolina. Each aerodynamic characteristic of the car must measure within a tight parity window of the target to pass homologation and be cleared to race.

Target aeromaps have been developed by the Supercars team and one car from each manufacturer is tested against these at Windshear and, if it measures within the various parity windows, is homolgated and cleared to race

Window shopping

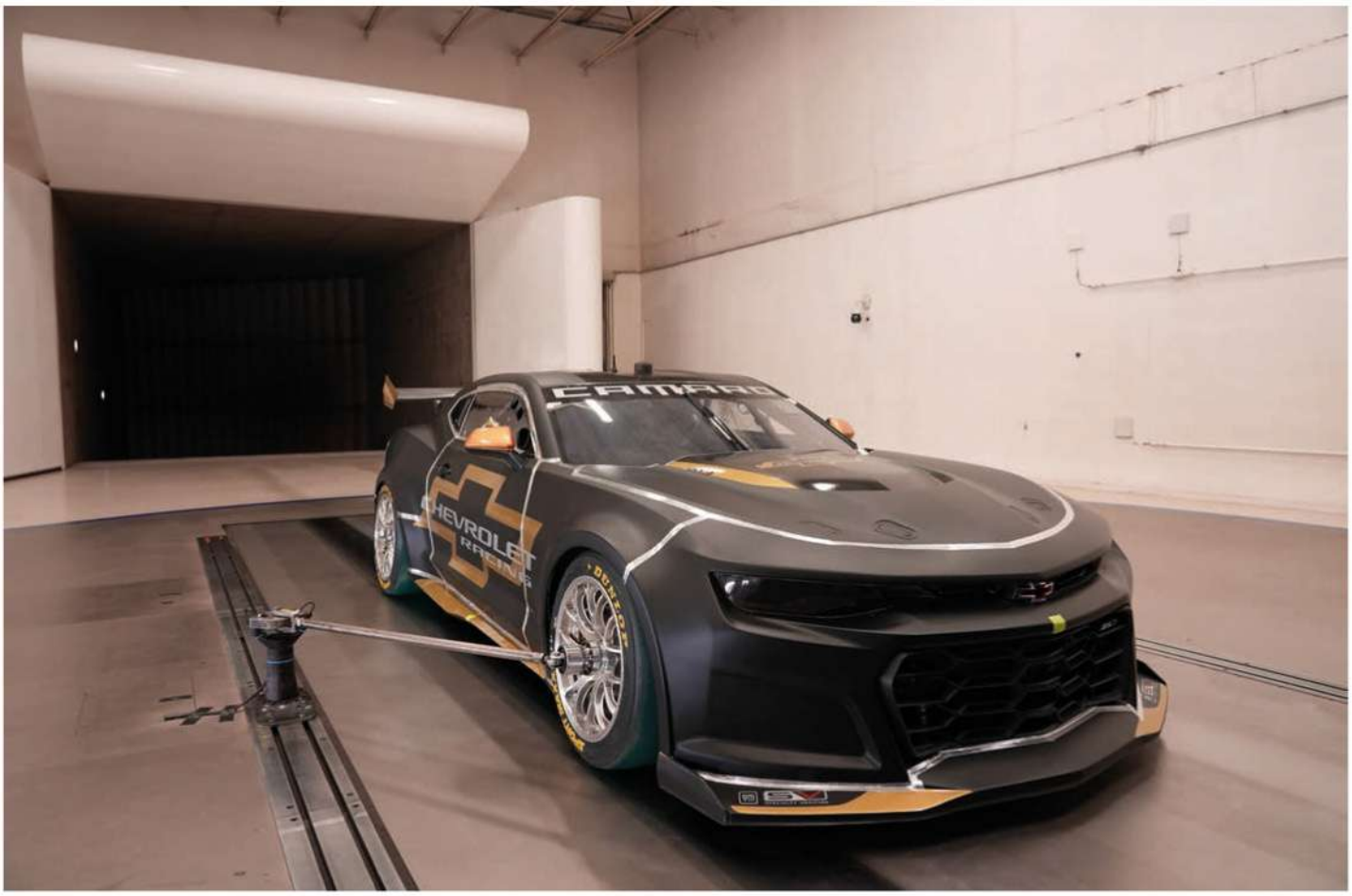
'Determining the parity windows for each performance differentiator is actually easier than it sounds,' comments Kapper. 'We typically have two manufacturers [currently Chevrolet and Ford], though next year will be three with Toyota coming in. But if we were to define a new engine c of g pillar, for example, this would be built around making measurements of both the current Ford and Chevrolet engines and simply aligning the two to create a target point. So, it's almost a balance of technical performance.

'Typically, the car that has the ability to perform better sets the benchmark, and the other manufacturers have to move towards that benchmark,' continues Kapper. 'Unless they are unable to, in which case the better performing manufacturer must adjust. The amount of adjustment required is defined by the scientific testing process we've developed, such as the dynamometer and wind tunnel tests.'

That development process is well established. Australian Supercars has been a technical parity formula for over 30 years now, since the days of Holden vs Ford Group 3A cars in 1993. Back then, engines were restricted to 7500rpm and a compression ratio of 10:1. The next generation of car, Project Blueprint, arrived in 2003 and brought with it standardised chassis pick-up points, driving position, wheelbase and track.

'Up to and including Project Blueprint, the cars were built out of road car body shells, but COTF [of 2013] was the first generation with a fully controlled chassis design and a standard, purpose-built platform'

Mitch Timms, motorsport development and strategy manager at Supercars



At Windshear, cars are measured against target aeromaps that define downforce, drag, lift-over-drag ratio and aerodynamic balance for a sweep of ride height, yaw and roll angles

In 2013, the Car of the Future (COTF) was introduced, which carried over the engine from Project Blueprint but marked a step change in the tightening of what teams were allowed to develop themselves.

'Up to and including Project Blueprint, the cars were built out of road car bodyshells, but COTF was the first generation with a fully controlled chassis design and a standard, purpose-built platform,' explains Mitch Timms, motorsport development and strategy manager at Supercars.

This effectively halved the cost of building a Supercars chassis, with the aim of attracting new manufacturers who could enter the sport and immediately be competitive. However, to distinguish the different manufacturers, parts of the road car, such as the side pressings, were integrated into the control chassis with customised fixings so the road car's exterior panels could be fitted.

Opening doors

The discussion about allowing twin-turbo four cylinder and V6 engines to race alongside the traditional V8s began in 2016 and, although Triple Eight Race Engineering built and tested a prototype, the concept was parked. 'That's the reason behind the name change from V8 Supercars to Supercars, because there was a time where the championship was going to run a variety of engines,' reveals Timms.

'More or less everything is controlled for Gen 3, apart from the body shape and the engine, which is manufacturer specific'

Perry Kapper

'The Gen 2 era for the 2018 season was originally meant to include a relaxing of the engine platform requirements, but in the end became just a small bodywork change,' he adds. 'We opened the regulations up from being a four-door sedan, so the Holden ZB Commodore became a five-door hatchback and the Ford Mustang became a two-door sports car.'

For the 2023 season, the Gen 2 field of cars were passed down to Supercar's feeder series, Super 2, and the main championship switched to a completely new Gen 3 car.

'Stepping from Gen 2 to Gen 3 was the biggest wholesale change ever made in the Supercars category,' highlights Timms. 'The whole car was entirely new. We changed the aerodynamics package, the engine and the chassis platform, as well as both the front and rear suspension.

'One of the aims with Gen 3 was to better suit the body style of the two-door cars because for Gen 2 we had quite a high roll hoop and the Mustang had to be distorted to fit it, which was time-consuming and costly. The aerodynamics had also started to get a bit out of control, with too much downforce, so we decided to make the wings smaller as well.'

'More or less everything is controlled for Gen 3, apart from the body shape and the engine, which is manufacturer specific,' adds Kapper. 'This has made our parity process more important than ever. Teams used to be able to improve their car's performance by developing new suspension, tuning the aerodynamic package or optimising the vehicle's c of g, but they can no longer do that. What that means for us is that all the teams are now operating within a specific window and they've got no ability to move that window, so the competitiveness of the championship is now heavily reliant on our parity process, so we have to get that right.'

Challenging approach

Of course, a major challenge with any performance equalisation strategy is dealing with unintended disparities that surface on track. The most recent example of this was at the start of 2023 where the rollout of Gen 3 revealed a design element on the Mustang that resulted in an aerodynamic discrepancy.

Toyota

While the current parity process is well established, with just two competing manufacturers, the system could return to the spotlight when Toyota enters the series with its Supra model in 2026

After a comprehensive evaluation, Supercars, along with the homologation teams, stipulated adjustments to the Mustang's rear wing, side skirt and front fascia elements to try and reduce drag, as well as re-distribute rear downforce.

So how does Supercars monitor technical parity between cars during race weekends? 'Although we don't adjust performance based on lap times, we do analyse lap times to establish any trends of one manufacturer outperforming another,' explains Kapper. 'With everything now so tightly controlled, this is a good indication that a disparity exists.

'We also have access to all the team's data and live telemetry, as well as the measurements we take during scrutineering. We have a really good database now of who runs what car where, and we can use that information to make informed decisions. But always, if we find something that is not aligning, it must fall within the parity pillars we have, so that we can demonstrate a technical explanation and then begin conversations with the homologation teams and manufacturers.'

Supercars also fit additional sensors and a logger to one car from each manufacturer during race events. This records in-vehicle measurements related to engine and aerodynamic performance to support the parity process. 'We measure in-session data as well to ensure the parity metrics we define are accurate,' highlights Timms. 'Typically, our parity testing is done in isolation at the wind tunnel or on dynos, but this doesn't guarantee parity when you bring everything together during a race. So we run additional torque sensors, load cell particular components and use pressure tappings on certain cars. We then loop this information into our active CFD program and correlate with wind tunnel data. We're always exploring sensitivities and ensuring teams aren't pushing boundaries where they shouldn't.'

'Although we don't adjust performance based on lap times, we do analyse lap times to establish any trends of one manufacturer outperforming another'

Perry Kapper

Cost control

Alongside maintaining competitiveness, another driver behind Supercars' technical parity process is controlling costs. This allows the championship to be affordable, encouraging healthy grids, without having to introduce a cost cap. However, this is becoming increasingly difficult, with teams constantly pushing for performance and expensive technologies such as simulation becoming more available.

'We deal with this by limiting the data teams have access to,' explains Kapper. 'Teams can develop their own simulation tools but, ultimately, they need access to representative acceleration and tyre data, which they can't get with the current restrictions we have in place. They have some information on the hard and super soft tyre from our tyre tests for example, but not for the new soft tyre, which we rolled out this year. This makes it difficult to build refined tyre and vehicle models, preventing simulation costs from spiralling out of control.'

Another significant cost to teams is the number of people travelling to race and test events. To help reduce this, one of the philosophies for Gen 3 was to make the car easier to work on and minimise the amount of specialist tasks required. As an example, the category decided to standardise dash configurations to avoid data engineers spending their time developing and deploying bespoke displays for each driver.

'Everyone needs a dash display and a customised configuration doesn't add any performance or improve the racing, yet teams

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To encourage teams and drivers to move up the Australian Supercars ladder, the Super 2 feeder series needs some technical overlap with Supercars, and generally uses the previous generation car

were spending ages on implementing their own,' says Timms. 'By standardising this component, teams no longer need one data engineer per car, reducing the number of people they need to take to events.

'Of course, that work doesn't go away, it just gets centralised and absorbed by us. So another challenge for us as a category is to make sure we have the capability to take on this extra workload in-house, on top of all our other scrutineering, technical parity and responsibilities of running the championship.'

Next generation

Although discussions have already begun around the next generation of Supercars, Gen 4, there is no timeline or target date set yet.

'There are several moving parts to define first, before we can establish the direction of the next era of Supercars,' says Timms. 'There is the potential of expanding to an international series, where we could run the Gen 3 car and develop Gen 4 for the main championship. Or we could run Gen 4 in both, and Gen 3 filters down to Super 2. Whatever we decide, we also need to factor in the relevance of Super 2, which is something we've come to realise over the years.'

Super 2 is the feeder category for Supercars and is a competitive, 24-car strong racing product that accompanies the main championship as it tours Australia. The category uses either the previous generation of Supercar, or the current generation, but built a few years earlier. The challenge Supercars has is striking the right balance between having some overlap between the two series, but not too much that the lines become blurred.

'There is the potential of expanding to an international series, where we could run the Gen 3 car, and develop Gen 4 for the main championship'

Mitch Timms

'Around 50 per cent of the Super 2 field are feeder programmes from teams in the Supercars championship, and their business model is to bring drivers through. The other 50 per cent are independent teams,' explains Timms. 'We need to be extremely careful with the relevancy between the two categories. If the cars are too similar, the main series teams could run their endurance drivers in Super 2 to get them ready for Bathurst, then pull them out and we are left with no one running in Super 2. But if the cars are too different, then the pipeline of junior drivers from Super 2 to Supercars is not as strong.

'We have to be mindful of this when introducing new generations of car, particularly as Gen 3 will need to be simplified for Super 2 to minimise costs and make it easier to run. We don't want to score an own goal and hurt the competitiveness and relevance of Super 2 by switching to a new generation of car too early.'

Whatever direction Gen 4 takes, arguably the biggest question is what will power it? Will the Australian championship stick to its V8 engine roots, or follow the likes of IndyCar by switching to a standardised hybrid powertrain to try and stay relevant to the road car world?

Hybrid potential

'First and foremost, we're an entertainment series, so a move to hybrid would have to enhance our show,' says Kapper. 'We have a plan of how we think we could integrate it effectively, but it's not a challenge that should be underestimated. There are plenty of examples of series that have introduced hybrid and it has come at significant cost to the teams, and the championship, without necessarily being a success.

'We wouldn't want it to become a development race either. Over the years, we've increased standardisation for cost and competitiveness reasons, so we don't want to suddenly create a whole new workload and therefore expense for teams.

'In terms of technical parity, the hybrid system would likely be a sub section within the powertrain pillar and the package would be just as tightly controlled. Although there would be some freedoms around how the teams manage and deploy regen', for example. Let's just say it's definitely on our radar, though it's not something we are considering in the short term. It would have to be introduced at a generational step in the car.'

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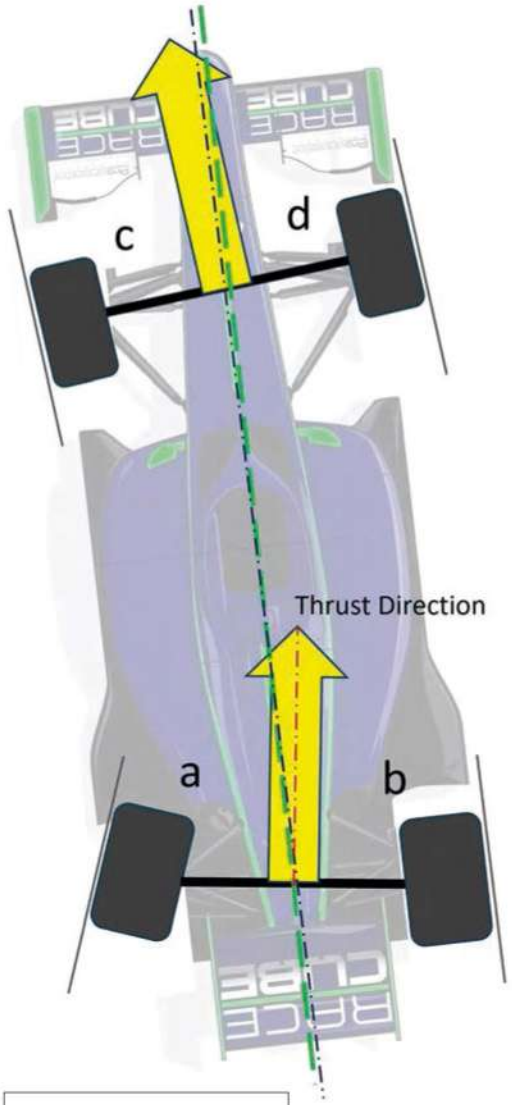
Racecube



Racecube bases its calculations on what it calls the 'true' dynamic centreline of the car, which isn't necessarily the chassis centreline. This tells the user immediately if the car has a thrust angle

Glossary of wheel alignment terms	
Camber	Inclination of the wheel when viewed from the front
Caster	How far the kingpin is offset from the vertical centreline through the wheel, when viewed from the side
Toe	Inclination of the wheel when viewed from above, relative to the car's centreline
Thrust angle	Angle of the car's centreline, either chassis or effective, relative to the rear axle

Good old-fashioned string is not always accurate enough when measuring wheel and suspension angles.* Racecar *looks at new tech on the block

By DANIEL LLOYD

Doing the mundane, preparatory tasks with accuracy is essential if an activity is to be rewarding. If a runner doesn't stretch before a marathon, they're setting themselves up for a world of pain. An angler who doesn't use a plummet to ascertain the depth of their swim is unlikely to catch many fish. Similarly, in motorsport, a mechanic who doesn't check the alignment of their racecar's wheels is going to come face-to-face with sub-par lap times and an irritated driver.

Having the suspension and wheels set up properly is an essential part of racecar preparation. It needs to be done before every trip to the track, and sometimes between sessions. Measuring the wheel alignment helps create a stable car platform for the track in question and offers a starting point for subsequent adjustments in the quest for lap time gains.

For decades, racecar mechanics around the world have relied on a simple, time-honoured method of alignment. Using string tied to a frame that creates a rectangular boundary around the car, hand ruler measurements are taken to find out the toe angle of each wheel. Caster and camber measurements may also be ascertained using the string boundary as a starting point. Knowing these values makes it possible for the mechanic to make accurate set-up changes that deliver tangible benefits.

Demand and supply

The string method has been the accepted way of doing things for many years, especially at club and national level. It is cheap and reasonably accurate, although in the last two decades, teams at higher levels and with bigger budgets have invested in more sophisticated and accurate technology. This demand has been met by the development of digitised measuring systems by companies like Beissbarth, CP Tech (SetupWizzard) and Manthey, all of which use lasers and sensors.

Wheel alignment tech continues to evolve, and new systems are being introduced that claim to do the job quicker, with greater accuracy and minimal fuss. One of them is Racecube, a brand of Aether Vehicle Technologies, which has been piloted by a handful of teams since 2024. It was set up by Matthew Jeffreys, a former design engineer at the McLaren Formula 1 team. Jeffreys was involved in chassis and suspension design at Woking for over 20 years, helping develop cars such as the MP4/4, which famously won all but one race in the 1988 season.

After leaving McLaren in the mid-2000s, he set up his own consultancy, conducting design and simulator development work for various clients. During that time, Jeffreys met Fernando Arrudo, a wheel alignment specialist who had written some clever algorithms that would go on to form the basis of the Racecube system. The hardware has been manufactured and honed by Progressive Motorsport, the British company that Audi contracted to help engineer its hugely successful LMP1 cars. So, there are plenty of bright minds behind it.

'When you use string… you can easily be half a millimetre out using that method, depending on how accurate your eyeball is'

Matthew Jeffreys, founder of Racecube

Margin of error

'When you use string, you're effectively measuring with a ruler across the front and rear positions of the rim against a bit of reference wire,' says Jeffreys. 'You can easily be half a millimetre out using that method, depending on how accurate your eyeball is.'

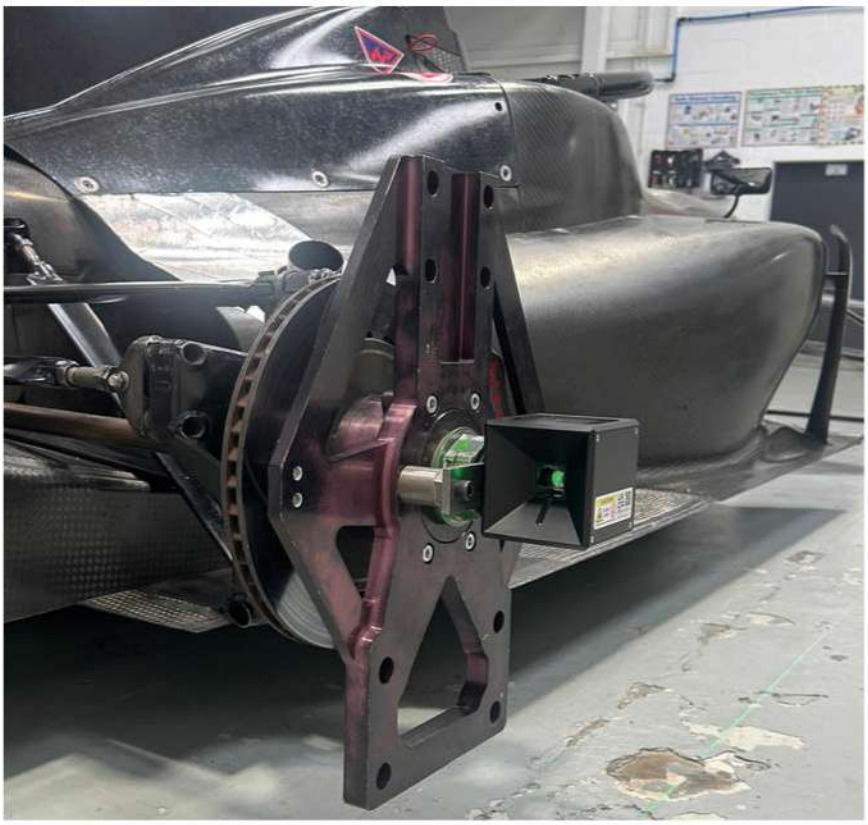
Half a millimetre doesn't sound like much, but it can be a lot in the context of racecar set-up. For instance, if you're trying to figure out the toe angle of one of your Formula 4 car's 13-inch front wheels, reading the distance from the back of the rim to the string at 0.5mm more than it really is equates to around five minutes of a degree (sometimes it helps to visualise a single degree as a clock, divided into 60 one-minute sections. One minute is therefore one sixtieth of a degree).

If you measure the toe angle as 20 minutes of a degree, but you have an error of five minutes, the true toe-in could be anywhere in that quite significant error window. Racecube claims to reduce the margin for error to +/- one minute of a degree.

'If you want to make a change, you don't know where you've come from and where you're going to,' says Jeffreys. 'With the laser, and the scales being six or seven metres apart, it's effectively like having a wheel of six or seven metres in diameter. It's that which gives it the accuracy of +/- one minute.'

A Racecube wheel alignment involves placing bars on the ground at the car's front and rear. The cube is affixed to the wheel with a magnet and spirit level. From the cube shoots a laser that projects its beam onto the bar, which has an accurate ruler printed on it.

The laser readings are manually entered into a tablet and visualised in two ways. The standard output presents the individual wheel and total toe values, while the so-called Cube Vector output presents the results as a function of the total toe and resultant steer vector for both axles. It also gives a traffic light indication to tell the user if the wheel angles need adjusting.



Daniel Lloyd

The cube in the Racecube system attaches to the set-up wheel (Double R here makes its own) and projects a laser to graduated bars at either end of the car, which reveal a host of wheel angle values

Thrust angle

The Racecube algorithm calculates the 'true' centreline of all four wheels relative to each other and the road. The other way is to use the centreline of the chassis as the reference plane for measuring wheel angles, but Jeffreys claims Racecube is unique in its approach here. Using the chassis centreline is flawed, he says, because not all chassis structures and suspension mounting points are entirely straight. This could be intentional; IndyCars, for example, are set up with asymmetric suspension for ovals to make best use of the track's inclination. However, it's likely to be unintentional for a car that needs to handle left and right turns on a conventional circuit. When this is the case, a tiny discrepancy emerges between the chassis centreline and the true centreline. It might only amount to a couple of minutes of a degree but, when the chassis centreline is taken as the reference, Jeffreys argues, it means the vehicle's true wheel alignment cannot be accurately measured.

'If you measure with string, you get the individual toe angles, but you don't get the relationship between that and what the wheels are seeing on the ground. You can get them relative to some kind of enforced reference frame – usually the car body – but the car body has nothing to do with the driving direction, and how the wheels are [positioned] relative to each other.'

Once the true centreline is calculated, it is possible to see if the rear axle has a thrust angle. The thrust angle is the relation between the rear axle and the chosen centreline. A car has a zero-degree thrust angle when the axle and centreline are perpendicular to each other. When a thrust angle is present, the car will pull in one direction on straights. To dial this out, corresponding adjustments can be made to the toe of the front wheels. Another way is to zero the thrust angle during a thorough wheel alignment procedure.

One of Racecube's main arguments is that the thrust angle cannot be accurately measured if the chassis centreline is used as the reference plane. Its reasoning is that measuring against the chassis centreline will either exaggerate or understate the thrust angle, whereas using the true centreline will give an accurate picture of how off-kilter the rear axle is. A mechanic checking each wheel angle against the chassis centreline might detect a thrust angle greater than what the true centreline would show.

'If you measure with string, you get the individual toe angles, but you don't get the relationship between that and what the wheels are seeing on the ground'

Matthew Jeffreys

This could cause them to adjust the toe more than is necessary so, rather than dialling out the thrust angle, they end up over correcting.

'People who set their cars up with string automatically assume there is zero thrust angle because you cannot measure it with string,' says Howden Haynes, owner at Progressive Motorsport, who used digital and string-based methods to set up Audi's LMP1 cars. 'You can on bigger, digital systems but they're not as accurate as this.'

Pilot scheme

Double R Racing, an experienced single seater outfit from Woking, has been an early adopter of Racecube. The team elected not to race in 2025, instead concentrating on an intensive test programme with a range of Euroformula Open and FIA Formula 4 cars that sees it travelling to tracks around the UK and Europe almost every weekend. Consequently, team principal, Anthony Hieatt, reckons he operates the busiest stable in the country, despite its lack of competitive action (a return in 2026 is on the cards).

Double R purchased three Racecube kits and has been using them both at its factory and trackside this season to measure toe. It often found that it would be slightly down on top speed, despite running what Hieatt describes as a 'faultless' HWA engine.

'I would be asking myself, why is this car down? We'd go into wheel bearings, everything,' he says. 'You could be a millimetre and a half out [on toe], and it would be

CP Tech

Underneath this car you can see the green laser curtain that's part of the SetupWizzard system by CP Tech. It creates a virtual floor, ironing out any inconsistencies with the ground

crabbier, inducing more drag. A car could be up one weekend, then down the next, and the four wheels not being perfectly aligned played a huge part in that. Since we've been using [Racecube] our quality control is a lot better. I'm relaxed about our straight-line performance now, whereas before, it was always at the forefront of my brain.'

Hieatt adds that string-based wheel alignment on junior single seaters has become more time consuming with the introduction of larger rear impact structures (RIS) for safety. The process increased to around 40 minutes on the Dallara 320, the car previously used in Euroformula Open and Super Formula Lights, as lots of parts had to be removed before wheel alignment reference bars could be fitted. Since adopting Racecube, that time has been halved as the gearbox-mounted RIS doesn't need to be taken off.

Competitive market

Racecube is just one example of the latest development in wheel alignment technology. There are multiple players in a competitive market, all jostling for teams' custom. Another company that's part of this movement is CP Tech, which this year introduced a new series of its SetupWizzard system, including new software. The German firm has worked with teams that have achieved recent success at the 24 Hours of Le Mans, Nürburgring and Spa.

'Wheel alignment wasn't developing like some other things in motorsport, such as software and the cars themselves. It was a little bit behind,' reflects Nico Ehlert, head of business development at CP Tech. 'There's huge potential in terms of accuracy, user-friendliness and AI. What can AI do when it comes to measuring, recording and evaluating historic data? Maybe, in the future, you're no longer telling the system which set-up to run, but the system is telling *you* which set-up you should run.'

The challenge for companies making such systems is to convince teams to part with thousands of pounds for something that forces them to change their established ways

CP Tech has been working hard on mobile wheel alignment systems that are used at the track. For example, SetupWizzard can generate a virtual laser floor that zeroes out any ground-level gradient, no matter how slight.

'Teams now want a tenth of a millimetre in accuracy of the ride height,' says Ehlert. 'That's why we create a virtual floor. Once the car is settled on the scale, you're measuring from the bottom of the car to a laser curtain that is at the same height as the contact patch of the set-up wheel on the scale. This gives the exact ride height, digitally measured.'

For conventional wheel alignment, SetupWizzard has three grades of system with different functionalities. In general, the car is lifted on its jacks and the provided set-up wheels are attached, to eliminate standard wheel tolerances and provide access to suspension components. Measuring platforms are then put under each wheel and the car is lowered onto them. Track width compensation from the front to rear axle is done automatically using the SetupWizzard digital integrated laser sensing system. The measurement involves a laser from the left rear assembly projecting onto the digital sensor at the left front. Although SetupWizzard doesn't currently identify if there is a thrust angle, CP Tech is plotting its introduction in an update to the system. It is therefore something at the forefront of the wheel alignment development race.

'In our case, it automatically measures the track width between left and right, front and rear, via a laser sensing system,' says Ehlert. 'From there, we know the difference between the track width of front and rear.'

Laser wheel alignment systems are a far cry from the traditional string method. The challenge for companies making such systems is to convince teams to part with thousands of pounds for something that forces them to change their established ways. Teams might be happy using string but, if they want to reach that last minute of a degree of accuracy, it's hard to ignore what else is coming to the table.

Forze feedback

After more than three years of development, the Forze IX hydrogen prototype made its long-awaited race debut at Assen

By DANIEL LLOYD

Prior to its race debut, the Forze IX had its first shakedown at Zandvoort in November 2023, followed by demonstration laps at Assen, alongside the Forze VIII in August 2024

The 24 Hours of Le Mans is not expecting to have hydrogen-fuelled cars on the grid until 2028 at the earliest, but this doesn't mean similar machinery is not already out racing. In August 2025, the Forze IX, a hydrogen-electric prototype based on an ADESS LMP3 car, made its debut in a Supercar Challenge round at Assen in the Netherlands.

The milestone had been a long time coming; the group behind it from Delft University of Technology (DUT) unveiled the concept more than three years ago, in January 2022. It was far from a perfect weekend, as the car ran with only one of its two fuel cells fitted and failed to finish both races. However, for a team made primarily of students on a gap year between Batchelors and Masters courses, it was a huge achievement. *Racecar Engineering* last covered the Forze IX in May 2023, when the concept was young. With its race debut now in the bag, it felt fitting to revisit the programme and find out what has changed.

The Forze IX is the latest in a succession of racecars built by Forze Hydrogen Racing. The first was a boxy-looking kart from 2008 but, over the years, faster and more sophisticated hydrogen-electric vehicles have been built, and a Le Mans-style sports prototype design was adopted. The rear-wheel drive Forze VIII of 2018 raced in the Sport class of Supercar Challenge against Peugeot RCZs and Renault Clios, while its ninth-generation successor has been developed to run with four-wheel drive against GT machinery.

Innovative solution

The front and rear drivetrains of the Forze IX are designed to capture heat energy generated under braking and store it in a supercapacitor, which then releases it to four electric motors, one for each wheel. The other source of power is a pair of independent EKPO fuel cells, which convert hydrogen gas and oxygen from the air into electrical energy.

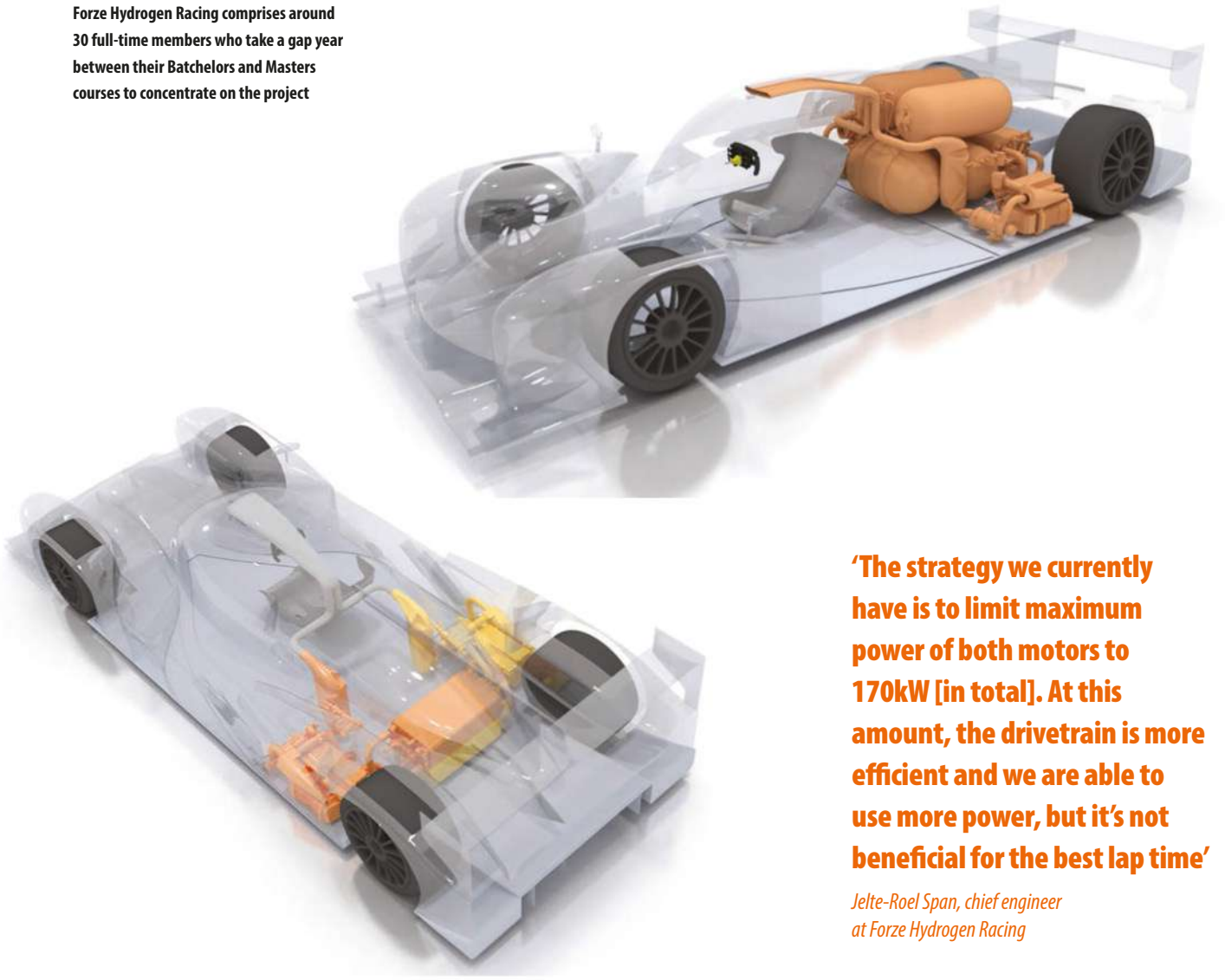
It is a highly complex vehicle, so it has been a relatively slow process to gradually integrate the power, drive and cooling systems

The system has a theoretical maximum power output of 720kW (around 965bhp) with everything working flat out. Currently, the limit is closer to 360kW (482bhp) because only one fuel cell and the rear drivetrain are operational. However, the car is currently producing less than that because of how much electrical energy the fuel cell can send to the two motors continuously. It is a highly complex vehicle, so it has been a relatively slow process to gradually integrate the power, drive and cooling systems.

'During the race, we were running one fuel cell continuously at 95kW,' says Jelte-Roel Span, chief engineer at Forze Hydrogen Racing for the 2024-'25 cohort. 'When we're braking for a corner, we're always getting that 95kW and using it to charge the supercapacitor. After the corner, we have some power left, as the buffer is full. At that point, we can choose how much power to use from the buffer.'

Unloading all the stored electrical energy might give superior acceleration out of a turn, but this would quickly expire and leave the driver with no power for the straight.

Forze Hydrogen Racing comprises around 30 full-time members who take a gap year between their Batchelors and Masters courses to concentrate on the project



'The strategy we currently have is to limit maximum power of both motors to 170kW [in total]. At this amount, the drivetrain is more efficient and we are able to use more power, but it's not beneficial for the best lap time'

Jelte-Roel Span, chief engineer at Forze Hydrogen Racing

'The strategy we currently have is to limit maximum power of both motors to 170kW [in total],' adds Span. 'At this amount, the drivetrain is more efficient and we are able to use more power, but it's not beneficial for the best lap time.'

The two main ways of accessing that missing power are to increase the limit at which the first fuel cell can run continuously, and to integrate the second fuel cell. As Span summarises: 'Once we have more fuel cell power, we can use more motor power.'

Stacking cells

The fuel cell is positioned centrally, behind the monocoque and nestled beneath the hydrogen storage tanks. When the second fuel cell is integrated, the pair will be stacked one on top of the other. Between them will exist an interface where air and hydrogen enter each cell's cathode, from the atmosphere and onboard storage tanks respectively. A propulsion system using multiple fuel cells requires what's called a Balance of Plant (BoP – if you dare!), which is essentially a group of components that ensures the two cells work in harmony.

BoP components include air compressors, blowers for recirculating hydrogen, radiators and cooling pumps, all of which are packaged in the Forze IX's sidepods. Currently, only the left BoP is operational as there is only one fuel cell installed in the car.

The cooling system comprises five radiators, including a large one in each sidepod for cooling the cells. Between the sidepods and the rear wheels are two smaller radiators that are ducted to cool the supercapacitor, the drivetrain and the fuel cell compressors.

'We have air compressors for the fuel cell that need electricity and cooling,' says Span. 'We also have a radiator in the front, under the monocoque, that will eventually be used to cool the front drivetrain. It also cools our low-voltage components. The two rear radiators have two cycles. So, in total, we have seven cooling cycles inside the car.'

Storage tanks

The Forze IX is designed to have four tanks storing a total of 8.5kg of gaseous hydrogen at 700bar. 'The reason we chose gas and not liquid is because, at the time we developed this car five years ago, liquid was further away than it is now,' explains Span. 'Also, because these gaseous tanks have been proven to be safe, even in a big crash.

'The stronger you make a liquid tank, the less temperature isolated they will be. They will have a lot of heat coming in and the liquid will start boiling inside the tank. For us, that isn't an option yet, but it could be in the future, because it has a higher energy density.'

So far, only three of the four tanks are being used. This is because the team decided three would be enough for the power they could generate with a single fuel cell and rear-wheel drive layout. The fourth tank will be added once the rest of the propulsion system has been installed.

There were multiple reasons for using four tanks, holding a little over 2kg of hydrogen each, rather than a single tank like that in the liquid-fuelled Mission H24 Evo prototype. One reason was that, with limited space in the car, larger tanks would be harder to package than four small ones. Another was that the chosen tanks were a known quantity, having originated in the Hyundai Nexo SUV. Their ability to handle thousands of cycles from empty to full appealed to the Forze team,

even if a custom-made tank could potentially store more hydrogen and weigh somewhat less.

The hydrogen itself is drawn from public refuelling stations. According to the European Hydrogen Observatory's May 2025 list, there are 21 hydrogen refuelling stations in the Netherlands that cater to cars with 700bar tanks. There are two within 20 minutes' drive of DUT.

Fresh set of eyes

The 2024-'25 cohort inherited the Forze IX with the aim of making it race. Their predecessors had statically tested the powertrain components, first separately and then integrated into the car on the DUT dyno. Track testing followed, where the regenerative braking system was validated. However, a loose nut caused one of the individual motor gearboxes to break. Each gearbox is a two-stage device that breaks up the high 30,000rpm running status of each motor. The first stage is a bevel stage at a 90-degree angle, followed by a set of planetary gears to further reduce the driveshaft's speed. The driver doesn't shift gears in the cockpit, like in some multi-speed electric cars.

The transmission breakage meant the first job for the new cohort in the autumn of 2024 was to re-design the gearboxes: 'We stuck to the old design as much as possible, but changed the locking mechanism that keeps the gears in place,' explains Span. 'We made a custom design for that. In early 2025, we got our parts in and integrated them. Luckily, our main sponsor, Shell, was able to provide those within eight weeks.'

That wasn't the end of the remedial work. 'Both of our motors from the development phase of Forze IX were prototypes. They had a few design flaws, which shortened their lifespan. To improve them, the supplier changed the dimensions a bit. This meant the production version of the prototypes we have been using wouldn't fit in our car.'

Increasing the size of the motors required the team to build a bigger housing and enlarge the gearboxes. Easier said than done as, on the Forze IX, the drivetrain housing is a structural part of the carbon chassis.

Although the fuel cell had been statically tested by the previous cohort, the 2024-'25 group sought to bolster it by developing a module to monitor the voltage of individual fuel cells. By doing this, anomalies within the fuel cell could be detected early on.

'We worked a long while on that,' recalls Span. 'We had to integrate a diagnostic system into the car that reads out these voltages. It gives us an error code if it thinks something is wrong, as the car is driving.'

The 2024-'25 cohort of Delft University of Technology gap year students inherited the Forze IX with the aim of making it race. Mission accomplished

The debut of a new hydrogen racecar is as much a challenge for the event organisers as it is for the team. Ahead of the weekend, the Supercar Challenge sent a scrutineer to DUT to check the Forze IX over. Because the series' regulations are tailored to petrol-driven cars, and because the FIA's hydrogen technical rules are still in draft, some intuition and trust was required on the organisers' part for them to be confident about its safety. Once at Assen, the Forze team held a presentation for the marshals to explain how to safely handle the car, while the event's medical team performed a mock driver extrication.

Race debut

Before the event weekend, the team emptied and re-filled the tanks several times and conducted a limited amount of dynamic testing. However, Assen was expected to be more of a test in race conditions than a competitive outing.

The Forze IX, driven by Jan Bot, set its qualifying lap time of 2m01.262s (50th out of 52 runners) during free practice, with permission from the organisers.

'There wasn't any disappointment from not finishing the race, as… our system was telling us, in the way it should, that we had a problem that could be diagnosed and solved'

Jelte-Roel Span

This was because the team wanted to start race one with full tanks. However, as qualifying was scheduled for race day morning, the team skipped that session so it could visit an off-site refuelling station. The car ended up only completing two laps in the Saturday contest due to a problem with a printed circuit board (PCB).

'Our whole embedded system is designed by ourselves,' says Span. 'It's a really big part of Forze, designing the electronics and writing the software for it. We are not completely sure yet why the PCB failed during the race. It hadn't happened before. We were able to replace the part, so that problem was solved.'

The second race on the Sunday was slightly more successful, the car completing 13 laps until it stopped around the halfway mark. A sensor in the control module that the team had developed picked up an anomaly with the fuel cell. Underneath that, the supercapacitor was nearing its temperature limit. To preserve parts, the team instructed Bot to stop the car.

'When you're operating the fuel cell at a higher temperature for long amounts of time, it can happen that the humidity inside the fuel cell gets too low,' says Span. 'The humidity was below 40 per cent. Optimally, you would have the relative humidity around 70 per cent.'

Milestone moment

Despite those dramas, the team judged the Assen event to be a success. There was a sense of celebration at seeing the Forze IX hit the track in a competitive environment, after more than three years of development.

'There wasn't any disappointment from not finishing the race, as participation was already a big milestone,' declares Span. 'The car stopped because our system was telling us, in the way it should, that we had a problem that could be diagnosed and solved. We are sure that once that has been done, with the next team, we can drive for a lot longer.'

Continuity has been a cornerstone of Forze Hydrogen Racing and is what has enabled this project to develop. As most students are only on the team for one year, there is a risk of the next cohort having to start from scratch. The team has accounted for this, though, with engineers from previous years being available to consult newcomers, ensuring the knowledge is passed on. This makes it possible for lessons to be learned from Assen, so the Forze IX can lap quicker and more reliably in the future. Further race outings are likely to focus on isolated events, rather than a full-season campaign.

The movement towards hydrogen's widespread use in motorsport continues.

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Time to shine

A behind-the-scenes look at engineering arguably the highest-downforce racecar on the planet

By DANNY NOWLAN

Regular readers familiar with my column should be well versed in my adventures in Time Attack by now. For the last two years, I've been working on the Tanuki Racing car, which runs in the Pro class. On 6 September this year, that car set one of the fastest ever lap times recorded at Eastern Creek, later re-named as the Sydney Motorsport Park.

What we'll be discussing this month is the story of how this came about, from a technical standpoint. For me, not only is it a technically fascinating story, it also happened on what I would call an amateur budget. This blows to smithereens motorsport regulatory bodies' mindless obsession with technically castrating racecars, as well as the limitations of spec formulas and BoP.

First, though, a quick bit of background on Time Attack as a competition, and on the Tanuki car itself. The goal of any car competing in the competition is to set the fastest lap time around a circuit. Straightforward stuff. The World Time Attack Challenge (WTAC) is held every September at Eastern Creek in Australia. To say the rulebook for the Open class and above is open is an understatement. The only real rule is that a car has to be *somewhat* based on a road car. In the Pro class in particular, apart from minimum ride heights and weights,plus some dimensions on bodywork, it's a case of knock yourself out.

Tanuki was designed from the outset as an unlimited Pro car. It started its life as a roadgoing Nissan Silvia S13, and from there became the MCA Hammerhead for use in WTAC. It was purchased by Wayne Lee in late 2022 and became Tanuki, the car shown here.

Downforce generator

In its current guise, the car has north of 1000bhp, and a C_LA well above 10. That latter figure is *not* a typo. I've had access to a lot of race data from all sorts of weird and wacky racecars over the years and I contend that Tanuki is the highest downforce racecar on the planet. I do not make that claim lightly as I've been doing all the simulation and race engineering work on it.

Let me stress here, though, that the success of Tanuki has been a team effort. I would love to say Tanuki's speed is solely down to my striking good looks and towering intellect, but that would be a lie. Wayne Lee, the car owner, hasn't blinked about spending the money, while David Lenthall and the crew from GT Auto Garage have done a great job running and maintaining what is a highly strung racecar with a colourful history. Andrew Brilliant from AMB Aero lived up to his name on the aerodynamics side, likewise Siim Õisma from Resolve Engineering on the structures. My two wingmen, Nick Ashwin and Mark McCoy, have done a masterful job on the dampers and running / tuning the car's systems and traction control respectively. I was simply the guy doing the simulation and race engineering work. Success in motorsport is *always* a team effort.

I should also add that since this is an active racecar, all scalings are blanked out and I won't be discussing set-up specifics here. That said, there are still some great lessons to be learned, and that is the goal of this article.

What started life as a regular production Nissan Silvia S13 has been developed into one of the quickest, and wildest, cars that competes in World Time Attack Challenge, held every September at Eastern Creek in Australia

Phase one

Our story starts in 2023. Tanuki was taken pretty much as is from the MCA Hammerhead, the car that won the WTAC event outright in 2016 and 2017 (with times of 1m22.192s and 1m20.971s respectively). It was always going to be a two-phase development programme. Phase one was to be a modest aero upgrade, with work on the car systems and set-up. However, during this phase, the Pro-Am and Pro classes moved away from spec treaded Yokohama A050 tyres to open tyre rules. Phase one therefore became about us getting our heads around that change. As we'll see shortly, phase two was forced upon us.

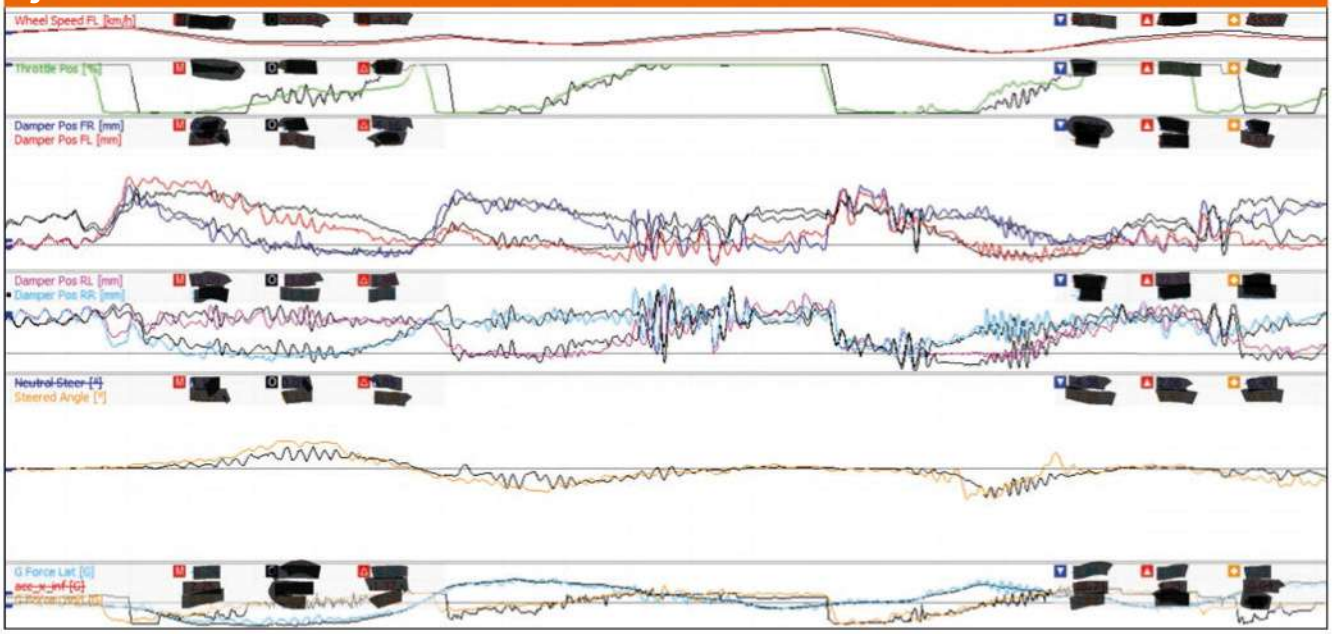
The only real rule is that a car has to be *somewhat* based on a road car

So, the goals of the initial phase of development were numerous. The first was to classify the aero changes and come up with a workable tyre model, as well as a calibration of where we needed to go in terms of tyre choice. The result of these efforts is shown in **figure 1**, with the key correlation parameters of the tyre model. As always, real data is coloured and simulated data is black.

The traces shown are speed, throttle, front dampers, rear dampers, steer and lateral and longitudinal acceleration. I should point out here that an awful lot of this correlation work was happening while working through significant teething issues with the car, bringing a professional driver up to speed and then trying to figure out what both the tyre and the aero model were doing. Which goes some way to explaining why you're not seeing the perfect correlation you have come to expect from ChassisSim.

Nevertheless, the exercise was enough to give us a solid baseline from which to figure out what had to be done, set-up wise, for the 2023 event. Tanuki's best lap time for that

Fig 1: Tanuki 2023 correlation



event was 1m20.453s, in the hands of experienced Supercars Championship driver, Tim Slade. Good enough for second place, during which a lot of key lessons were learned.

I'd like to make a point here about correlation. One of the pitfalls I regularly see people using simulation slip into is the obsession with making every trace look perfect. As you can see from **figure 1**, we were far from that, but by looking at the damper traces and the lateral and longitudinal *g*, we gained some good, useable information to move forward. The example presented here provides a good template of how close you need to be to make progress.

Phase two

Phase two, although it was planned right from the beginning, came about rather more abruptly when the rear suspension failed in the Pro-Am session on the Saturday of the 2023 event. Welcome to the joys of running a pre-loved racecar. This unexpected episode triggered two things: a complete re-engineering of the rear of the car, and the arrival of an unlimited aero package.

While the circumstances that triggered the progression were far from ideal, a lot of the changes we subsequently made were motivated by the running of the car we'd already done, as well as having a good simulation model to lean on.

The first port of call, then, was defining what we needed from the rear. A lot of simulation analysis went into this but, with the increased engine power we knew was coming, I knew it would need more force-based anti-squat and more motion ratio (damper / wheel). With that knowledge, I could turn over the simulated data from the fastest lap to Siim Õisma from Resolve Engineering and let him do the rest.

One of the pitfalls I regularly see people using simulation slip into is the obsession with making every trace look perfect

However, the big change was always going to be the aero package, and here is where Andrew Brilliant from AMB Aero decided to go all out. One of his previous Time Attack cars was the S15 Silvia racer for Under Suzuki. Having race engineered both, I am in the enviable position of being able to compare their aerodynamic qualities. Suzuki's C_LA was in the order of nine, which puts it just above DTM in the glory days and well in Pikes Peak territory. The goal of the Tanuki aero package was to create something unchallenged. Hence the detail in the front splitter and the size of the enormous rear wing end plates.

Rather than campaigning the re-engineered car in the Pro class in 2024, it was decided to run it in the Pro-Am category, this time with its owner, Wayne Lee, driving. As one of my motorsport mentors once said to me, sometimes you have to take a step back in a season in order to move forwards. We had a lot to get our heads around that season, and this approach turned out to be a smart move.

Firstly, we had to understand what Brilliant had given us. Now, my extensive experience with CFD has led me to the conclusion it resembles blue sky marketing. In other words, it is usually way too optimistic on downforce and drag prediction. I factored that into my set-up work but, when we arrived at Eastern Creek in 2024, I was in for a shock.

Before we discuss the data, I will say that I hand calculated the aero at end-of-straight conditions, only to discover – for the first time in my career – that the CFD had actually *under* calculated the car's downforce. The numbers I was seeing defied belief. So much so, I had to do the calculations three times!

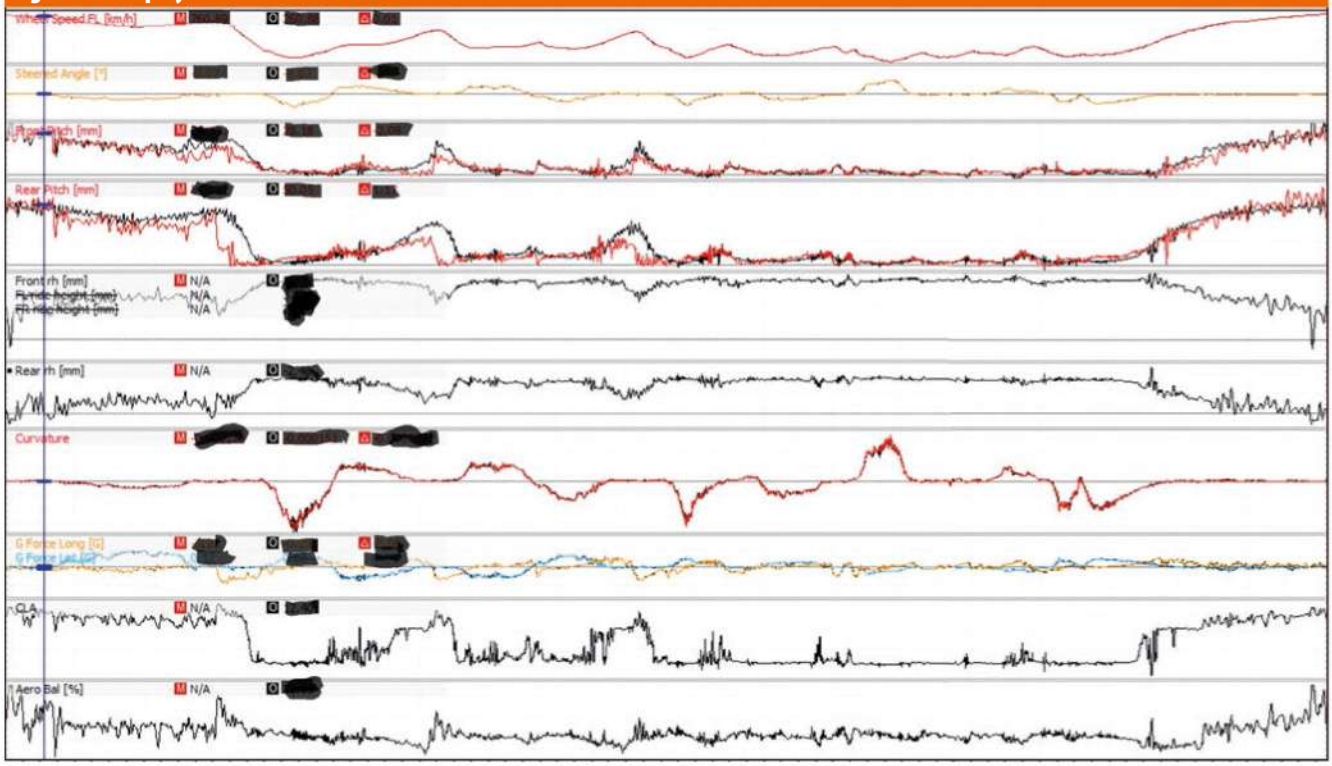
Refining process

Once I was absolutely sure they were right, I started to refine the aeromap, and here's where ChassisSim's track replay feature was a great help. This is shown in **figure 2**. What you are seeing here is the result of a number of iterations of the pitch sensitivity map. Driving this process were multiple things: firstly, I was focusing on correlating the front and rear pitch channels. However, as we didn't have ride height sensors, I was using the returned simulated channels from ChassisSim, such as ride height channels and the C_LA and aero balance, to help inform me of where I had to go. **Figure 2** is the result of that process.

It's relevant here to add a note to any younger engineers reading this. Rather than looking for some magic algorithm that will generate a perfectly correlated result, try looking at actual vs simulated data and then use the simulation as a calculator. That's what you're seeing in **figure 2**.

With all these ingredients in place, it was time to prep the car for the 2025 campaign, although that didn't all go quite as smoothly as we'd have liked. Firstly, issues outside the control of GT Auto Garage meant car prep didn't start until July of this year. Fortunately, with the information we had, we could run the shaker rig to optimise the dampers and, with DiL simulation, come up with a solid baseline set-up. More importantly, enough tyre modelling had been done to start informing the traction control algorithms.

Fig 2: Track replay simulation at Eastern Creek



Once the event started, the delays experienced in prepping the car, together with some general teething troubles, cost us valuable time. In short, the issues were as follows:

- In the lead up to the event, we had to switch front tyres
- The driver, Todd Hazelwood, was plunged in at the deep end (though given he had no opportunity to do any DiL work, let alone actual driving, he did an amazing job)
- I made a misstep in the rear damper spec, which dogged us all weekend
- The bump rubbers we ordered did a great job, but didn't quite have the rate required to support the car

The bump rubber thing was very much a mixed bag. Going into the event, I was terrified about how the tyres would react to very stiff bump rubber rates. On the flip side, I could use them, particularly at the rear, as a chassis tuning tool, which proved to be very effective.

A shining example of everything that *should* be great about racecar engineering

In addition to all the race engineering work happening during the day, a lot of ChassisSim work was going on at night. It's a common misconception that, once the race weekend starts, you put the simulator away. In this case, it saved my neck as I was able to use it to nail the aeromap. This is shown in **figure 3**.

Not only did I finally have confidence in the aero map, I could use it to pull out the tyre model from the data and give the driver useful feedback about where to make up time.

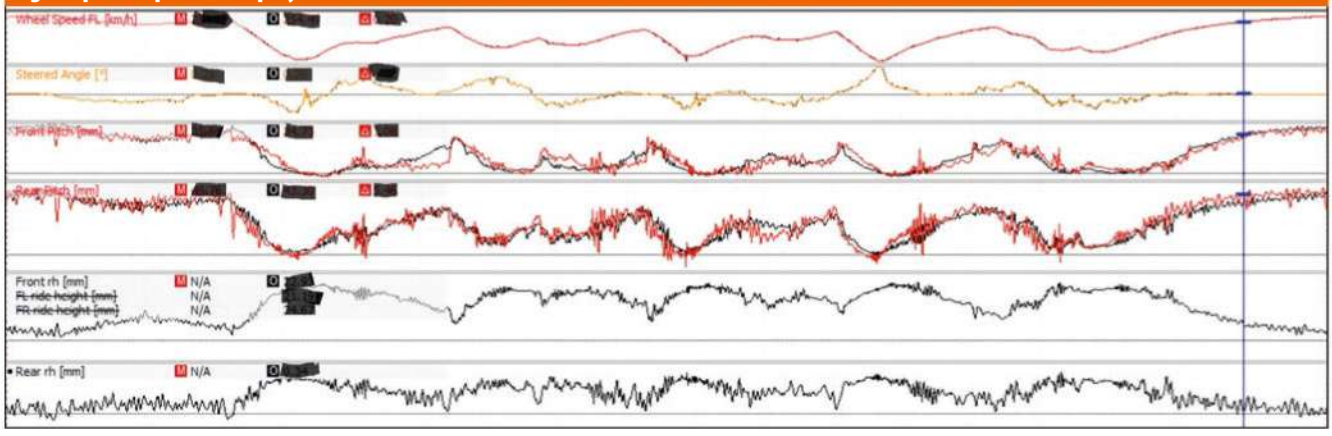
The team also had three Bosch Motorsport engineers in the garage, who helped integrate an advanced ABS mapping system for the car.

The result of all this was a winning lap time of 1m18.169s, a whopping 4.596s faster than the next best competitor. Was it the prettiest thing any of us had ever seen? Hell no. Was all the work we had done effective? Hell yes!

Before I sign off this month, I'd like to point out something about running a car when there's effectively no technical rulebook. In contrast to the banal world we live in where technological advancements in motorsport are seen as the enemy, or the crazy world where LMDh rolling chassis cost millions because they're so ridiculously complicated, this car was developed and run by a team of 12 people with a budget of under AUS$1 million (approx. £488,000 / $665,500). Now tell me how technology spoils the show.

Tanuki is a great example of what can be done when you just get out there and do it. Yes, there were setbacks, but it stands up as a shining example of everything that *should* be great about racecar engineering.

Fig 3: Open loop / track replay simulation for 2025



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GB3 car gets 'significant performance boost'

MSV

The updated GB3 car has completed two days of testing in Catesby's tunnel. Track runs with the same prototype car are also planned

The car used in the GB3 Championship is getting a 'significant performance boost' ahead of its second season, according to series promoter MotorSport Vision (MSV).

The Tatuus MSV GB3-025 was introduced to the UK-based series in 2025 with the goal of better preparing young drivers for Formula 1 by increasing power by 30bhp, upping downforce by 35 per cent and implementing a DRS system.

The car has already proven quicker than its MSV GB3-022 predecessor. The pole time at Brands Hatch GP was 0.819s faster this year, while at Spa-Francorchamps it was 1.216s faster.

However, with the consensus that even more performance could still be extracted, an update programme was launched for 2026. Measures to improve reliability have also been taken.

The package comprises a 'heavily revised engine' from Mountune, which has increased the displacement of the four-cylinder power unit from 2.0 litres to 2.4. The change is intended to generate a 25 per cent increase in torque. A revised power output figure has not been stated, although the car needs to fit within an FIA-defined power-to-weight ratio. Hence, the performance improvement is likely to come from better acceleration out of corners.

The reconfigured engine includes a new forged crankshaft, connecting rods and pistons. A CNC-machined, billet aluminium cylinder head with improved porting and gas flow replaces the old cast aluminium one and will contain new steel camshafts.

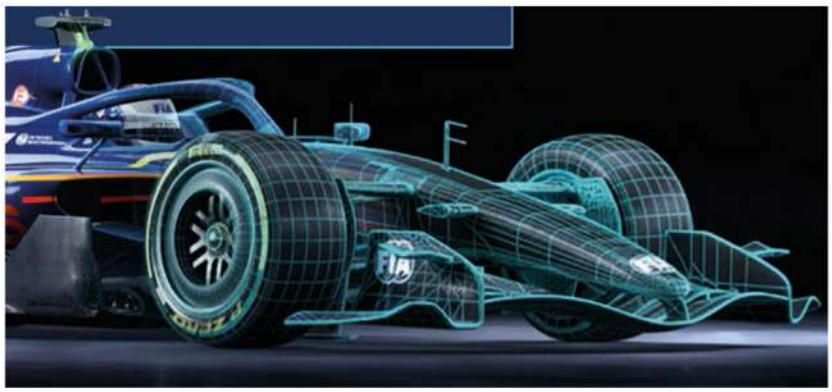
Engine installation has been made easier with refinements to the cam cover and cylinder head interface, as well as a revised A-frame to improve torsional rigidity.

'The Tatuus MSV GB3-025 cars introduced for this season have already established new lap records at the majority of circuits visited in 2025, but we know there is further performance in the cars that can be extracted with our upgrade programme,' said MSV chief executive, Jonathan Palmer. 'Equally importantly, we have focused on striving for perfect reliability, too. As is inevitable with a new car, we have discovered a few areas we can improve on and are fully committed to addressing these.

'Having worked closely with our teams, chassis designer, Tatuus, and engine manufacturer, Mountune, the 2026-specification GB3 car will build on the impressive performance levels seen this year. We are determined GB3 should be the leading championship in Europe for drivers to develop and prove themselves before joining F3 in the F1 support paddock.'

Teams can expect to receive their update kits in late 2025 or early 2026, the 'majority' of which will be supplied free of charge, to help control cost.

Siemens agrees digital twin deal with FIA



FIA

The FIA has been working with Siemens since 2022, using its cutting-edge software to make CAD designs for simulation

The FIA and Siemens have entered a multi-year partnership that will see the German technology company continue to provide the global motorsport federation with digital twin software.

The deal will see Siemens providing the FIA's engineers with its Xcelerator software portfolio to help with racecar design. The FIA is responsible for setting the technical rules for most racing categories and issuing homologations to cars that have been built to those rules.

Siemens Xcelerator includes Designcenter NX software, which the FIA will use to create digital twins of racecars on which performance simulations can be carried out. The idea is to reduce the need to produce physical prototypes, which the FIA says will bring environmental benefits. The federation has already used Siemens software to generate more than 14,000 CAD parts in over 10,000 CFD simulations.

'Siemens gives us the precision tools to design and test complex aerodynamic concepts virtually, reducing environmental impact while improving performance and safety,' said Jason Somerville, head of aerodynamics at the FIA. 'This technology is key to ensuring that racing remains closer, fairer, and more competitive, all while supporting our ambition to reach net zero by 2030.'

BTCC tries again with new junior series proposal

TOCA

TOCA was due to introduce an in-house junior series this year but, after parting ways with Chevron, it has re-started the process with Power Maxed Motorsport ahead of a planned 2027 debut

The British Touring Car Championship is having another crack at establishing its own support series for young drivers, in partnership with the Power Maxed Racing team.

TOCA, the BTCC promoter, has announced plans to launch an as-yet-unnamed series for 2027 based on a new, bespoke car that will be suitable for drivers aged 14 and up.

It had been on the hunt for a new organisation to develop its future junior championship car after ending its association with Dave Beecroft's Chevron brand, which had built a hot hatch-style racer for 2026.

Car specifications will be released 'over the coming months,' according to TOCA, which has published a rendering of a GT-style concept.

Motorsport UK, the national governing body, has preliminarily approved the blueprint, with formal ratification still to be obtained.

The car is being designed and built by Power Maxed Motorsport, a division of Power Maxed Racing, which has competed in the BTCC since 2015. It ran the Chevrolet Cruze in its first two seasons before starting a long association with the Vauxhall Astra.

'We are pleased to announce the introduction of a dedicated Junior championship within the BTCC package, commencing in 2027,' said TOCA chief executive, Alan Gow. 'Having received expressions of interest, it was clear that Power Maxed Racing were best placed to independently develop, build and supply the bespoke car for this exciting new championship. We look forward to sharing these plans as the programme progresses.

'We remain committed to creating the ideal and highest profile stepping stone for emerging talent and supporting the UK's ongoing legacy of producing top-level racing drivers.'

Power Maxed recently made the headlines when its factory burnt down, destroying its fleet of racecars. However, the team bounced back with support from the BTCC paddock to make the next round a week later.

TOCA has indicated that Power Maxed is basing its junior championship programme at a separate site, meaning the fire had 'no real impact' on its progress.

'We are proud to be producing a bespoke car for a new Junior championship on the TOCA package from 2027,' said Power Maxed managing director, Adam Weaver. 'Having been closely involved in all levels of British motorsport, we know what is needed for a successful junior programme, and PMR obviously possess the high-level of design and engineering expertise to build an outstanding car.'

SEEN: LANCIA YPSILON RALLY2 HF INTEGRALE

Stellantis

Lancia has been busy testing its new Rally2 machine and it is due to hit the stages soon. The Italian manufacturer, which produced the iconic Delta HF Integrale, Rally 037 and Stratos, is making a welcome return to off-road competition. The Rally2 concept sits above Rally 4 (212bhp) and Rally6 (145bhp) versions that were launched earlier this year.

IN BRIEF

Motul has joined forces with McLaren to supply the title-winning Formula 1 team with transmission lubricants. The arrangement will start in 2026, coinciding with the onset of new technical regulations.

Mercedes used a bio-based carbon fibre composite on the rear brake duct of its W16 that finished second in the Azerbaijan Grand Prix. The team said it replaced 30 per cent of the traditional resin with material from sustainable sources. The development was made in partnership with **Syensqo**.

Ford has rebranded its motorsport division to **Ford Racing**. The name was previously used until 2014 when Ford grouped it with its special vehicles department under the Ford Performance umbrella. However, the Blue Oval has stated it wants to 'simplify our branding back to our competitive roots' by reverting to Ford Racing.

The **Ford** Hypercar effort for 2027 will be run by an in-house team based in the UK, the American marque has confirmed. It will receive some technical and operational support from **Venture Engineering**. Most Hypercar manufacturers have recruited existing race teams to run their entries, such as BMW (WRT), Cadillac (Jota) and Ferrari (AF Corse).

Former Team Penske managing director, **Ron Ruzewski**, has joined Andretti Global as its team principal for the 2026 IndyCar season. Ruzewski was one of three Penske employees ousted after the team was found to have modified the attenuators on two of its cars at the 2025 Indianapolis 500.

RML Group has become the sole UK and European partner to **ChassisSim**, building on an existing partnership between the two companies. RML has used ChassisSim's simulation software for several engineering projects and will now provide race teams deploying the platform with 'consultation, technical support and integration services.'

IN BRIEF

The **Abu Dhabi Autonomous Racing League** (A2RL) held an online competition, called Sim-Sprint, ahead of the second edition of the real-world driverless car event. It was won by the Kinetiz team, which beat reigning AR2L champion, the Technical University of Munich, by four points. Sim-Sprint involves teams running their car control algorithms in a virtual setting.

Cosworth is ramping up its involvement in sim' racing, having partnered with Next Level Racing, which will provide the British engineering company with simulator hardware.

Max Verstappen stole the headlines at a recent NLS race, where he made his GT3 debut at the **Nürburgring** Nordschleife. However, the same event also marked the first time that a GT3 car had competed in the AT class for alternative fuel solutions. The entry was an Audi R8 LMS GT3 Evo II running on an E20 petrol biofuel from Volkswagen containing 60 per cent renewable components. The car was run by Max Kruse Racing.

Toyota Gazoo Racing and **Mission H24** have joined forces to develop the H24 Evo hydrogen car ready for testing in 2026. The car is equipped with a fuel cell rather than an internal combustion engine. The collaboration on aerodynmics has yielded larger louvres for more efficient extraction of air, clearing a passage under the body to allow cool air to reach the rear of the car, re-aligning front uprights to further help cooling, and a new rear wing that reduces drag. The skeleton of the car will be fixed in November 2025, and the body in February 2026. The ACO expects a hydrogen car to compete at Le Mans in 2028, but others consider 2030 to be more realistic.

Forvia will supply the hydrogen fuel tank to the **Mission H24 Evo**. The company was formed in 2022, merging Faurecia and Hella. It will develop a cryogenic system to store the liquid fuel at -253degC. OPmobility supplied the previous H24 car with a tank holding 8.6kg of gaseous hydrogen.

FIA drops EVs from rallycross championship

The FIA has laid out its plans for its management of the leading series in rallycross, including a switch back to internal combustion engine cars in the top class.

Since 2024, the FIA World Rallycross Championship (WRX) has featured a so-called 'Battle of Technologies' in which electric cars compete directly against ICE-driven machinery. That came after two seasons with EVs only. However, from 2026, electric racers are set to be dropped completely.

This, according to an FIA statement, is designed to 'simplify the competition, strengthen the grid and deliver the spectacle fans around the world have told us they value most.'

Simultaneously, the world championship will become the FIA European Rallycross Championship, consisting of a six-round calendar on one continent. The last two WRX seasons have already taken place entirely in Europe, while the last overseas event was the 2023 season finale in Hong Kong.

Plans to retain an international aspect are being forged with the introduction of a planned FIA Rallycross World Cup, in addition to the European Championship.

The proposals, which come after the FIA took over promotion of the world championship from WRC Promoter GmbH in March, are now subject to approval by the FIA World Motor Sport Council, which next meets on 16 October.

'The past two seasons have been a true battle of technologies, with electric and combustion power going head to head,' said FIA road sport director, Emilia Abel. 'This era showed how rallycross can lead in motorsport innovation, and the lessons learned will remain part of our DNA. The move to an internal combustion drivetrain builds on this foundation, delivering an affordable and accessible format to grow grids and intensify competition.

'With the European Championship providing a strong racing format, and plans – subject to the approval of the World Motor Sport Council – for a World Cup to create a thrilling global showcase, we are offering the best of both worlds as we transition toward the new technical regulations for the 2028 season.'

Those new regulations will be based on the new FIA World Rally Championship technical rules that are due to arrive next year.

Meanwhile, four-time WRX champion Hansen Motorsport, which has been running Peugeot 208 EVs in the series, has joined the nascent FIA Extreme H World Cup. The team is understood to still be interested in rallycross if sustainable fuels are used.

Jaanus Ree / Red Bull Content Pool

Despite the interesting Battle of Technologies concept, WRX has struggled to capture the motorsport mainstream's attention. The FIA is now targeting a reset as new regulations loom

New safety device to keep karts grounded

The FIA Safety Department has developed a new device aimed at reducing the likelihood of karts going airborne after an on-track collision.

It consists of a guard attached to the rear bumper that sits behind the rear wheel and covers a small portion of the tyre's side profile. This is designed to mitigate wheel-to-wheel contact between karts. The device was tested in race conditions for the first time in late September, fitted to Academy Trophy karts competing at the FIA Karting World Cup in Italy. The FIA is considering a wider rollout of the device to more categories in 2026.

'We're constantly researching safety innovations across motorsport categories at the FIA, from grass roots to Formula 1, and wheel protection is a promising area of development within karting to reduce the likelihood of karts lifting off,' says FIA safety director, Nuno Costa.

'Initial testing has shown that this device is very effective and we will closely study the results from the further testing in Cremona before seeking final regulatory and governance approval.'

Straight to the heart

The new *F1* film is helping build excitement in the business of motorsport

As one season ends, we move rapidly to another, with no time to waste. Great new ideas must be discussed, developed and made ready to use early next year. As a result of the vision and investment of Liberty Media, motorsport in the UK is growing fast and offers an exciting future.

This year has been a particularly complex one for those connected with automotive. This vital sector of our national economy continues to face substantial changes. The UK government remains determined to meet its net zero targets. These include that from 2030, no internal combustion engine vehicles are to be produced [in the UK] and, from 2035 – just 10 years away – 100 per cent of new cars and vans on the UK's roads must be fully zero emission.

That aside, there are still many exciting opportunities for our motorsport industry to consider, many aimed at developing cutting-edge technologies to help reduce carbon emissions. Motorsport rules now include carbon emission specifications, some of which will be of use to mainstream automotive companies.

Technology partner

I see motorsport becoming a highly valuable, advanced technology partner for the future world of automotive. Rapid development, and delivery, of innovative solutions, and a constant hunger for new technology are the lifeblood of UK motorsport. Both our racing and automotive sectors *must* work together to face, and resolve, future challenges.

British motorsport is currently enjoying a new lease of life. Liberty Media's investment in Formula 1, keeping its global headquarters in London, provides us with many golden opportunities. Some have already arrived as substantial inward investment from Aston Martin, Mercedes, Ford, McLaren, Cadillac, Haas and Audi, all create exciting prospects for our industry. It seems soon Ferrari could be the only F1 team with no operations in Motorsport Valley.

October is the right time of year for you to meet and speak to your old and new suppliers and potential customers alike. Our industry is very focused through the race season, so it is essential for you to meet to discuss new business and innovations to be delivered early in 2026.

The MIA's popular CTS Show, held in the famous Silverstone Wing on 15-16 October, is only a few days away as I write this. This highly successful, trade-only show is aimed exclusively at the international motorsport and high-performance engineering business community. It is the perfect opportunity for you, and your business, to build on the rapid growth of the Motorsport Valley network. Highlighted in our recent UK Motorsport Business Survey and Report from Grant Thornton, this showed an increase from £9bn to £16bn in revenues over the last 10 years, whilst employing 50,000 people.

The CTS 25 Show is growing year-on-year and has developed its reputation for business interaction

In recent years, Formula 1 has changed the face of racing substantially. It now embraces the importance and value of entertainment, alongside the competitive engineering challenge. The Brad Pitt film, *F1*, with Mercedes-AMG on board as a partner, has so far taken $624 million (£461 million) at the box office, making it the highest grossing film of 2025, as well as the most successful ever for Apple Studios.

The film has had true global impact, attracting a large number of young people, female and male. Such an audience creates a more stable and valuable long-term future for our industry. Its popularity will also spill into other motorsport series, whether that be endurance racing, rallying, touring cars, IndyCar or NASCAR.

Motorsport Valley, at the very heart of the film, will grow international recognition for the UK as the epicentre of the world's most successful motor racing championship. I am hopeful the UK government will now see and appreciate the immense value motorsport has brought, over so many years, to our national economy. They will surely want to attract inward investment, and the world's very best engineering talent to this country, welcoming the extraordinary and competitive engineers who make all the difference on and off track.

Many sourcing enquiries seek, through the MIA and our members, to engage with rapid response development and delivery of supplies for defence, marine and aerospace. Increased interest from international markets is led by the United States and Europe, which together make up the largest motorsport market in the world.

One of a kind

CTS 25, at the centre of Motorsport Valley, is your industry's own trade show, and the only one of its kind in the UK. With free entry and free car parking, all you have to do is focus on creating new business.

There you will find the latest technologies, talk with experts, discover new suppliers and make new business connections. The focus at CTS is on the industry that supports and supplies all forms of motor racing and keeps the UK at the forefront of international motorsport.

The true value of a good trade show lies in the quality of the people you will meet. The MIA CTS 25 Show aims solely to attract motorsport and high-performance engineering specialists; no consumers, no fans, no students, just the innovators, technologists and engineers who will help keep your business in the lead.

There will be around 100 exhibition stands, over 2500 trade visitors and some 40 business and technology leaders giving short, informative presentations at the popular Speakers' Corners. Each talk lasts just 15 minutes, but you can then continue discussions with the speakers at any one of the many meeting areas around the show.

Please **register now** for your **free entry ticket** for either or both days. The dates are 15 and 16 October 2025. I will be delighted if we meet there and hope that everyone enjoys the show. And good luck in attracting new business.

To register for a place at the trade-only CTS 25 Show, use the following link: rfg.circdata.com/publish/CTS25_Delegate/

Chris Aylett is CEO of the MIA (Motorsport Industry Association) www.the-mia.com

Rapid development, and delivery, of innovative solutions, and a constant hunger for new technology are the lifeblood of UK motorsport

Racecar engineering
Inside the world of modern motorsport technology

One direction?

Something that all agree is that sportscar racing needs a shake up

Sportscar racing has never been a simple affair. As many have written, often, the top class is one of the most complicated regulation sets to explain in racing. Overarching all of it is the existince of two types of car. One is LMDh, which permits four chassis constructors that the aumototive OEMs partner with, and a spec hybrid system. LMDh cars race in the Hypercar class of the FIA World Endurance Championship and the GTP class of the IMSA Sportscar Championship in the US; the rules are owned by IMSA and the ACO. Then there is the LMH rule set, which is owned by the FIA, and mainly races in the WEC. LMH involves the automotive manufacturers building their own cars from the ground up, including the hybrid system.

The two car types are governed by a Balance of Performance formula, which some say works, others disagree. The evidence, however, suggests it does not work: Ferrari won the first four WEC races of 2025 at a canter; Cadillac then easily won at Interlagos. This could be explained in a variety of ways, but the BoP tables are shared with the teams ahead of each round, and all say they can accurately predict who will win.

Eight and counting

Despite this overly complicated set of rules, an impressive eight manufacturers race in the WEC's top class, and three more are coming. Joining LMH manufacturers Aston Martin, Ferrari, Peugeot and Toyota, and LMDh manufacturers Alpine, BMW, Cadillac and Porsche are Genesis in 2026, and Ford and McLaren in 2027. Great Wall Motors and Lotus are said to be waiting in the wings.

At Austin, the confirmed manufacturers, along with Acura (which only races in IMSA at the moment), met to discuss what they all needed to stay in the championship. The idea is to simplify Hypercar, but the application of that idea is – you guessed it – more complicated.

The LMH cars have a front-mounted hybrid system, which delivers power over 190km/h but is most useful under braking. They also have very different floor designs compared to the LMDh cars, have more flexibility allowed in the bodywork, and are bespoke race chassis designed for a single purpose. The LMDh cars, meanwhile, have a simpler floor, do not have the brake drums to help control temperature within the wheel like their LMH cousins, but can deliver power from the rear hybrid system at any speed. Not that the power is extra, it replaces power from the ICE, but it can be used anywhere around the track.

One idea on the table at Austin was to have a common architecture across Hypercar. To do that, a manufacturer could build a rear-mounted hybrid system for its car. That would require a change to the regulation, though LMH manufacturers could continue to build their own hybrid systems, allowing Toyota and Peugeot to retain their relationships with Denso and Saft respectively. This would at least appear to be a logical approach.

Another proposal on the table is that LMDh cars could have brake drums like the LMH cars.

Tunnel vision

One aspect that will certainly help in the future is that all cars are now measured in the same Windshear wind tunnel by the same engineering team. Before, IMSA used Windshear in North Carolina and the FIA used Sauber in Switzerland, and there were even key differences in the way the cars were tested. In both, the cars are painted grey to avoid shadows that hide areas of flexibility, but one tunnel's regulations mandated the floor of the car also be painted, the other did not. One tunnel also demanded the air intake to the cockpit be covered, while the other did not allow it.

The idea is to simplify Hypercar, but the application of that idea is more complicated

There was also, opined one manufacturer, a number of differences between the test programmes, so to have just one wind tunnel, with one engineering team managing the data, will be a good step.

However, BMW and Toyota are very much against designing new cars to a common platform. The BoP, they both argue, is a bigger issue that needs to be solved. Some manufacturers are in favour of building a new car, as long as it keeps the party together for as long as possible, while others have been pragmatic, saying whatever a manufacturer needed, they could do it.

Then, towards the end of the Austin WEC weekend, it transpired that Peugeot, which needs a new car for 2027 and confirmed it could not wait until discussions were concluded before starting work, and also could not delay to 2028, has built its next prototype with a front hybrid system. So, it seems, there's little more to be said about convergence. If it happens, it will either mess up Peugeot's plans again, or a unified rule set will be introduced for 2032.

The FIA met with the manufacturers on the Friday following the Austin race to discuss the future of the rules and other proposals that were put forward. What comes out of the discussions, and the timeframe to implement any changes that are agreed (and who will still be around to race with them) is anyone's guess.

ANDREW COTTON Editor

PIT CREW

Editor
Andrew Cotton
Email andrew.cotton@chelseamagazines.com

Deputy editor
Daniel Lloyd
Email daniel.lloyd@chelseamagazines.com

Sub editor
Mike Pye

Art editor
Barbara Stanley

Technical consultant
Peter Wright

Contributors
Mike Breslin, Gemma Hatton, Karl Ludvigsen, Javier Mayordomo, Christian Menath, Danny Nowlan, Don Taylor, Adrian Villar

Photography
Mike Breslin, Ryland Jones, James Moy

Acting director of commercial revenue
Simon Temlett

Advertising manager
Lauren Mills
Tel +44 (0) 07508 540 224
Email lauren.mills@chelseamagazines.com

Marketing executive
Loulou Easton
Email loulou.easton@chelseamagazines.com

Head of Marketing
Seema Bilimoria

Subscription Marketing Manager
Parveen Bhambra

Publisher
Greg Witham

Managing director
Marie Davies

Editorial and advertising
Racecar Engineering, Chelsea Magazine Company, 111 Buckingham Palace Road, London, SW1 0DT **Tel** +44 (0) 20 7349 3700

Subscriptions
Tel: +44 (0)1858 438443
Email: racecarengineering@subscription.co.uk
Online: racecar-engineering.com
Post: *Racecar Engineering*, CDS Global, Tower House, Sovereign Park, Lathkill Street, Market Harborough, LE16 9EF

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Fax +44 (0) 20 7429 4001
Email info@seymour.co.uk

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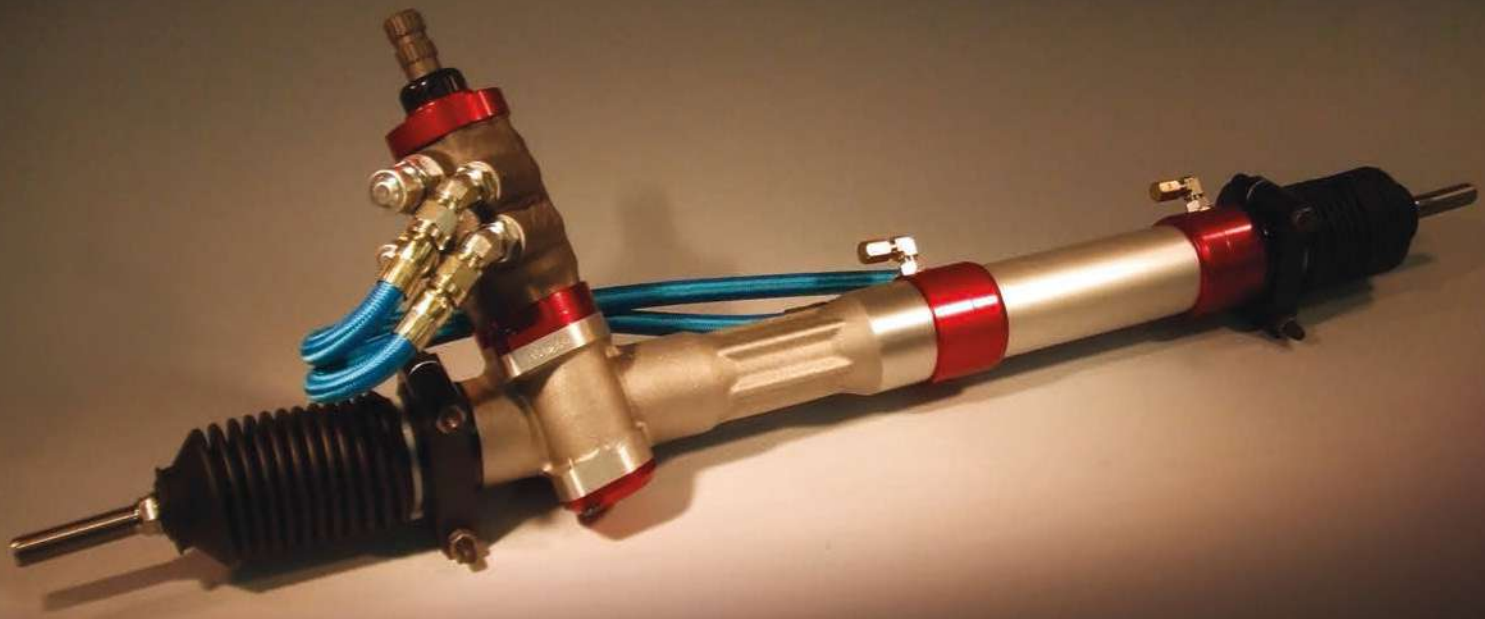

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